Controls Software Group

EPICS Graphical Archive Data Display Tool
Software Requirements Specification

Version 1.2

Revision History

Date	Version	Description	Author
<11/01/05>	1.0	Initial draft	Anthony Bavuso
<7/24/06>	1.1	Updated document per comments from review on 7/17/06	Anthony Bavuso
<8/26/06>	1.2	Added bit masking requirement.	Anthony Bavuso

Table of Contents

Software Requirements Specification

1. Introduction

Several graphical tools have been used in the past to view control system data. StripTool is used to view current epics control system process variables. Xarr is used to view archived epics control system process variables.

This document will describe the requirements for an integrated graphical data display tool that will display both live channel access data as well as archived data.

1.1 Purpose

This document fully describes the external behavior of the graphical archive data display tool. It also describes nonfunctional requirements, design constraints, and other factors necessary to provide a complete and comprehensive description of the requirements for the software.

1.2 Scope

This document covers the EPICS graphical archive data display needs for the accelerator at Jefferson Lab. These requirements reflect only the needs of Jefferson Lab, though it is recognized that other organizations in the EPICS community may be able to use the display tool in their working environment.

1.3 Overview

The remainder of this document covers the specific requirements and constraints placed upon the graphical display tool.

2. Overall Description

The Jefferson Lab control system is a network of distributed computer systems that communicate between themselves and to the outside world using the EPICS Channel Access communications protocol. Users have a need to view the state of control system variables both in the present and in the past. Currently the StripTool program is used to access live EPICS data. Xarr is used to gather control system data from the past. Each tool although performing a similar function, i.e. retrieve and graphically plot control system data, has a different interface and look and feel. The graphical display tool must be reliable and it must provide users the features needed to effectively analyze and/or troubleshoot the current and/or past state of the control system.

3. Specific Requirements

3.1 Functionality

3.1.1 Display current data and archived data

1. The tool must display live control system data and archived control system data.
2. The tool must be able to display live data even if access to the archived data is unavailable, and conversely must be able to display archived data even if access to live data is unavailable.
3. It must be clear to the user whether the data displayed is archive data or live data. Data must be presented in a clear way that doesn't require the user to look at the time axis and see that the data is for the current time.
4. The tool must be implemented such that the retrieval/display of archive data must not interfere with the display of live data.
5. The user must be able to toggle between displaying live data and archive data, or both.

3.1.2 Channel selection

1. The user must be able to clearly select which channels are to be displayed by the tool. There should be no ambiguity as to what the user is selecting. If for a given channel name there are multiple representations the user must be given enough information to differentiate between the representations.

2. The tool must be able to allow selection of channels using a wildcard type specification.
3. The tool must allow the user to select a logical grouping of channels.

3.1.3 Time range specification

1. The user will be given the ability to specify the begin and end time of the required data for each channel specified in the history data request.
2. The user will be able to specify the time range in an absolute date/time to a one second resolution or the user may specify a relative time from the time of request by the number of days, seconds, or years from the time of the request.

3.1.4 Display channel metadata

The tool must have the ability to display to the user metadata about a channel. For example, if the archive channels have configuration metadata associated with them then the tool must at the users request display the configuration metadata for the channel in question.

3.1.5 Data dumps

1. The user must be able to dump data to a file. The data dump formats must be compatible for importing into spreadsheet tools and other common analysis tools used by the user community.
2. The tool must also allow for a screen dump of a plot to a picture format like a jpg. At least one of the picture formats used must be compatible with the picture formats used by the elog system.
3. The tool will allow for the user to specify a default directory for data and or image dumping, such that the tool remembers the directory location and the user does not have to input the directory location each time.

3.1.6 Multiple instances of process

The user must be able to run multiple instances of the display tool process on the same host.

3.1.7 Error reporting

The tool needs to clearly indicate to the user errors from both channel access and the history server and if possible to indicate corrective action.

3.1.8 Archiver Instance Specification

The tool must allow the user to specify which archiver instance to use to retrieve history data. If no archiver instance is specified the tool will use a default setting.

3.1.9 Plot window configuration specification

The user should be able to specify which channels to plot from the command line, their time ranges, plot window screen location, and window size such that when executed the tool loads the needed data and plots them based on the command line switches. The user must at least specify the channel name and a reasonable default will be used for all other parameters that are not specified.

The user should also be able to specify a file that contains all the information as well. Additionally a user will be able to save the current plot configuration to a file that can be opened in the future and will recreate the current plot window locations, window sizes, channels, etc.

3.1.10 Plotting

1. The tool must graphically plot one or more channels versus time on one plot.
2. The tool will have the capability to generate multiple plots of one or more channels per user request.
3. The tool must plot one or more channels versus another channel.

4. Each plot will have an optional legend clearly indicating which line in the plot correlates to which channel.
5. Each plot will have an optional title.
6. Each plot should clearly indicate the X and Y axes.
7. If there is a known bar of uncertainty for a channel the tool will be able to graphically display the uncertainty range.
8. The tool should clearly indicate when data is available and when it is not, i.e. the connect and disconnect events need to be rendered such that they clearly indicate when data was gathered and when it was not.
9. The user needs to be informed if the data points that are rendered are recorded data points or are interpolated points.
10. When a plot is requested over a large time range the tool will plot the data as it is received. This is as opposed to the tool waiting until all the data is retrieved and in one shot updating the plot.
11. The user must have the capability to print a plot to a color or black and white printer.
12. The user will have the ability to highlight a particular channel plot in a plot that contains multiple channels. For example, the plot line could be highlighted by increasing the line width or other graphical elements to make the desired channel plot stand out among the others on the plot.
13. The user will have the ability to mouse over a channel plot line and the have the x and y coordinate values displayed for the mouse pointer location.
14. When the user has asked for several channels to be plotted in one plot window, the user will have the ability to hide the plot line of one or more plot lines in the plot.
15. The tool will allow the user to select the graphical display style desired for each plot line in the plot window. The user will be able to select one of the following interpolation methods: a point rendering where the plot is a series a discrete points; a linear line fit where straight lines are displayed connecting the data points; a spline fit; and a cubic spline fit. The user will also be able to select the color, line width, and other graphical display style like dashed lines or dotted lines for each channel plot.
16. The tool will allow the user to offset the Y axis up or down in the plot for each channel. For example, if the user wants to view data for two channels and does not want the two channel's plot lines to overlap. The user will be able to adjust the Y axis scaling such that the desired plot will move up or down in the plot window.
17. The tool will allow the user to place one or more cursors on the plot for each channel. Cursor in this case is used to mean a small graphical element indicating an x,y coordinate on a plot line. The user will be able to "dial" the cursor left and right like the cursor function of an oscilloscope. The tool will display the x,y values at each cursor location. The user will have the ability to add two cursors to a plot line and ask the tool to compute the difference between the two cursor locations i.e. x2-x1 and y2-y1.

3.1.11 Axes and Axes Scaling

1. The graphical plotting must allow for multiple independently configurable Y-axes scales. The user should be able to select the Y-axis scaling per channel when creating a plot. The user will be able to specify a minimum and maximum value of the axis, the number of ticks on the axis, and the scaling type i.e. linear and logarithmic.
2. The tool will provide a configurable linear time axis. The user will be able to specify a minimum and maximum value of the axis and the number of ticks on the axis.
3. The user must have the ability to rescale an already existing axis.
4. The tool must allow the user to auto scale on a channel by channel basis. By auto scaling it is meant that the Y axis scaling will be selected such that the maximum amount of plot area is used. The tool will auto scale each channel by default when no scaling is selected by the user.
5. The tool must be able to draw every data point in a manner that the user can clearly see given a reasonable time axis scaling selection.
6. The user must have the capability to zoom in on a plot and to move the plots time axis forward or backward.
7. The tool must allow a "rubber band" or lassoing (like the Xarr feature) selection of a plot area for rescaling of both axes. To clarify, the user will have the ability to wrap a box around the desired area of interest in a plot and the tool will rescale the plot such that the box defines the limits of the plot area.
8. The tool must provide a *back* or *undo* feature such that if the user zooms in or uses the lassoing feature, the back feature may be used to restore the zoom setting to the setting prior to the zoom in or lassoing action.
9. When used for correlation plotting, the tool will provide the same X-axis functionality as are provided for the Y axis.

3.1.12 Data Analysis

Although the tool is not intended as a full featured data analysis tool, some simple analysis functions will be provided. For more complex analysis, the user will be encouraged to dump the data and import it into a full featured analysis package.

Below is a specification of the analysis features that will be provided:

1. When viewing time domain plots, the tool will display at the user's request the minimum, maximum, mean, and variance of the data plotted in the plot window for the requested channel.
2. The tool will allow the user to perform a linear fit of data on a selected time range and will display the kai-squared for the fit. The linear fit feature will be used in both plots of a channel versus time as well as correlation plots of channel versus channel.

3.1.13 Annotations

One common use of the tool will be to report on a specific behavior or event in the control system. Users will have the ability to add annotations to the plots to annunciate an important event in the plot. The user will be able to add text boxes, arrows, circles, and other simple geometry. Additionally at times the channel name displayed in the legend or elsewhere is not descriptive enough to convey the desired meaning. For example, a user may want to display a long name like "beam current" as opposed to R2XXITOT. The tool will allow the user to supply a more descriptive channel name for display in the plot window. The tool will allow the user to toggle displaying of the long name or the actual channel name.

3.1.14 Data Selection

Users may want the ability to perform operations on archived data prior to plotting. For example, users may wish to bin or filter the data, especially when performing correlation plots.

3.1.15 Trend Analysis

There exists use cases where the user wants to see a channel or set of channels displayed in a fixed amount of time where the user is not concerned with viewing all the data points but instead only desires to see trends in the data. For example, users will request temperature data to see temperature changes due to the changes in season. In this case the user is not interested in every temperature measurement but only the trends.

The tool will allow the user to request a plot be displayed in a fixed time amount of time per channel. The user is not concerned about the technique used to achieve the fixed time constraint. If the data is somehow processed to achieve the constraint, the tool must then give the user enough information on the processing used so that the user can correctly interpret the data presented in the plot.

3.1.16 Bit masking

There are PVs in the control system that are a field of bits where each bit or a group of bits in the word have special individual meaning. The viewing tool must allow the user to mask off a bit or bits such that the resulting plotted value only has the bit or bits of interest. The tool must also allow the user to mask and shift the bits. For example, a binary value 1001 where you want to mask the lower two bits. With just the mask applied, the value would be 8. With the mask and shift, the value is 2.

3.2 Usability

3.2.1 Ease of Use

The tool must be implemented in such a way so that a user can run the tool and perform common simple functions without pouring through a user manual. Advanced functions should be available but not clutter the interface or confuse the novice user. A user within 5 minutes of reading online help should be able to use the tool to perform simple tasks such as simple plotting of a channel. The user will need to read the users manual to understand and

fully utilize advanced functions.

3.2.2 Use of Tool from External Offsite Location

The tool will be at times used from an offsite location to trouble shoot control system problems. The user must be able without excessive hassle to use the tool such that the desired data is retrieved and displayed in a timely manner. For example, the xarr tool can be currently used at home from a PC system using Exceed logging into the control system network. The tool must at least be useable from home in a similar manner to xarr.

It is assumed that the performance of the tool may degrade depending on the speed of the network connection used.

3.3 Reliability

3.3.1 High Reliability

The tool at times will be used by analysts to troubleshoot critical problems in the control system. A failure of the tool could cause an increase in machine downtime due to the analyst/operators inability to assess the control system state. The expected mean time between failures is 6 months.

3.3.2 Error checking of all data inputs from external systems

The tool must gracefully handle errors from all external systems including the archive server and channel access. Improper or unexpected behavior from an external system must not cause the tool to fail unexpectedly.

3.4 Performance

3.4.1 Response to user input

The tool must be implemented in such that it will respond to the user in a timely manner. For example, the tool should not freeze up during a long data query with no screen refresh, but should continuously inform the user of its progress and allow the user to cancel a request or make additional requests while the tool is processing another request.

3.4.2 Data points processed per second

The tool will be able to process at least 4000 total data points per second i.e. the sum total of all data points for all requested channels.

3.4.3 Large data set requests

The tool must provide to the user an estimate of time to process a plot request. For example, a progress bar showing a percentage of complete would satisfy this requirement.

3.5 Supportability

3.5.1 Maintainability

The tool much be written such that when a problem or bug is found that maintainers can troubleshoot and fix the problem with a mean time to repair of 5 days.

3.5.2 Extensibility

The tool will be used by a large user community for many different purposes. It is expected that users will request new features and enhancements to the tool. The tool must be written such that when a new feature is identified the tool can be extended to add the new feature without unwarranted difficulty.

3.6 Design Constraints

3.6.1 Hardware Platforms

The tool must run on HP and Redhat Linux 4WS.

3.6.2 Epics and Channel Access

The accelerator control system is implemented using Epics and channel access. The tool is constrained to using the channel access interface to access current time control system state.

3.6.3 Archiver API

The tool must use archiver API to retrieve archived control system data.

3.6.4 Timeframe

The Controls Software Group has selected the mya archiving system to satisfy JLabs archiving needs. A formal schedule has yet to be developed for the mya project, but its rollout is expected early 2007. At the time of mya roll-out, users will need some form of graphical archive display capability of mya archive data. This graphical display capability may be an initial release of the product that only implements a basic set of the requirements defined in this document.

3.6.5 Budget

A $5,000 maximum budget is allowed for the purchase of third party libraries or licenses of products to implement these requirements. The man-power budget for both this tool and the textual tool is 1 FTE.

3.7 On-line User Documentation and Help System Requirements

The tool will make available full online user documentation. Individual features will have help buttons to assist the user where appropriate.