Software Support during a Control Room Upgrade

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ABSTRACT

In 2004, after 14 years of accelerator operations and commissioning, Jefferson Lab renovated its main control room. Changes in technology and lessons learned during those 14 years drove the control room redesign in a new direction, one that optimizes workflow and makes critical information and controls available to everyone in the control room. Fundamental changes in a variety of software applications were required to facilitate the new operating paradigm.

A critical component of the new control room design is a large-format video wall that is used to make a variety of operating information available to everyone in the room. Analog devices such as oscilloscopes and function generators are now displayed on the video wall through two crosspoint switchers: one for analog signals and another for video signals. A new software GUI replaces manual configuration of the oscilloscopes and function generators and helps automate setup. Monitoring screens, customized for the video wall, now make important operating information visible to everyone, not just a single operator. New alarm handler software gives any operator, on any workstation, access to all alarm handler functionality, and multiple users can now contribute to a single electronic logbook entry. To further support the shift to distributed access and control, many applications have been redesigned to run on servers instead of on individual workstations.

INTRODUCTION

Inspired by a Spring8 presentation given at the Workshop for Accelerator Operations in March 2003, the Operations Group Leader was motivated to update the main control room at Jefferson Lab. The original control room design included walls of equipment racks made obsolete by new technology, and ergonomic assessments deemed the noise level too high and placement of displays incompatible with 24-hour occupation. The main impetus for change, however, was the need for improvement of the workflow dynamics of the control room. Arrangement of the old operations workspace made it difficult for the Crew Chief to oversee accelerator operations and assist support staff while troubleshooting problems. In addition, many controls applications were confined to a single workstation further impeding communication and collaboration. [1] Although the infrastructure changes to the control room are those that are most visible to outsiders, the Jefferson Lab Controls Group was responsible for some of the more subtle contributions throughout the planning and implementation of the new operational environment.

Figure 1: Old control room (left) vs new control room

DISPLAY WALL

One of the main motivations for the new control room layout was making information readily available throughout the control room. The solution: a 2X4 array of 50" Christie DLP (Digital Light Processing) rear projection cubes driven by a dedicated video controller. Controls Group system administration personnel were instrumental in researching and selecting the cubes as well as the Jupiter 980 display controller. The display cubes themselves were selected based on their high performance (XGA 1024x768 resolution per cube), reliability (designed to support 24/7 operation), and maintainability. The Jupiter display controller was selected simply because "it was the best of the best." The video processing is done on cards instead of spending valuable CPU resources. Major hardware components (power supplies, fans, display cards, switch cards, and rgb input cards) are all "hot-swappable," and the API is well documented, allowing expansion for future applications. [2]

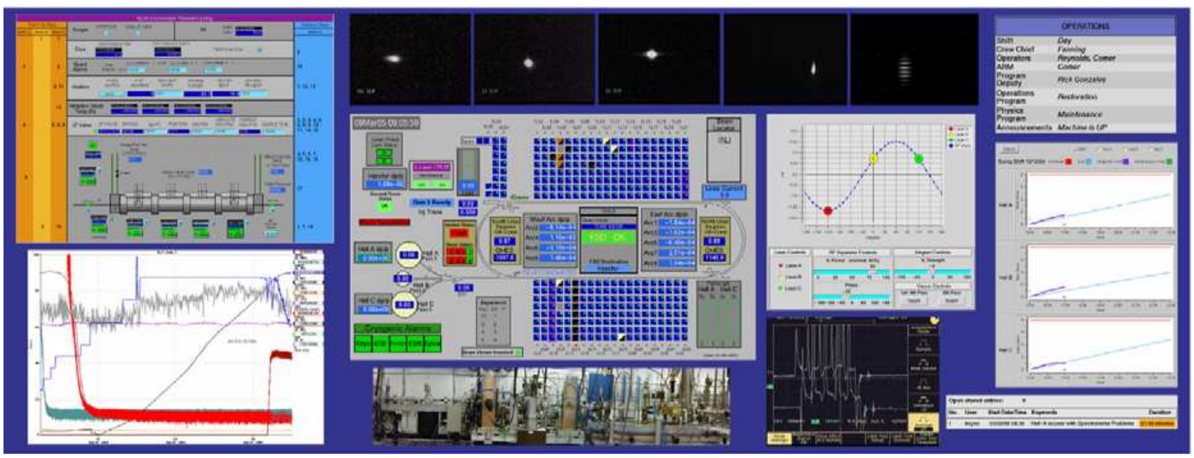

Figure 2: Typical video wall layout

Once the determination of hardware was made, system administrators were tasked with devising the method(s) of controlling the new display and controller. Most of the workstations in the Jefferson Lab control room are Hewlett Packard computers running HPUX11-11. The Jupiter system operates on Microsoft Windows. The operators need a seamless interface between the two. Operators must be able to launch all UNIX applications, display control screens, and pipe video to the display…all from any workstation in the room.

A combination of Exceed and ssh are being used to integrate the PC and X computing environments. Operations uses ssh.com's ssh client to run X applications on remote UNIX workstations, and then Exceed's X server is used to display the application GUIs onto the display wall. No major X server compatibility issues have arisen since using this configuration.

Although the vendor provided tools to remotely control the display wall, an open source solution was found. A VNC (Virtual Network Computing) server has been installed on the Jupiter, allowing clients to connect from any operating system currently supported by our controls group (Linux, HP-UX, Windows). Using this interface, a client, approved on the configurable client security list, can take control or view the display from their desktop.

EDM

A primary function of the display wall is to display synoptic controls screens. At the time of the renovation, the MEDM display manager was being used to interface with EPICS. A conversion from MEDM to EDM had already been discussed and planned by the controls group, so when a display manager decision needed to be made regarding the video wall, EDM was the logical choice. The newer display manager handles .gif and .png images better, enhancing the usability of the wall display screens. EDM has greater control of font styles and sizes, the better to develop screens specifically intended for the large format. MEDM screens do not always resize as expected; this has been corrected with EDM. Symbols, color rules and tables are all features of EDM that have been found to be useful on the display wall as well as for general controls. [3]

After a full year of using EDM exclusively on the video wall, EDM has been thoroughly tested and exercised. The decision has been made to convert all existing MEDM screens to EDM and use EDM as the display manager for all controls by the end of October 2005.

CROSSPOINT SWITCHER

With the new control room layout, the mostly unused equipment racks were dismantled and removed. Two analog devices remained: the oscilloscope and the function generator. Both were required to be remotely configurable, with their resulting output displayed on the video wall.

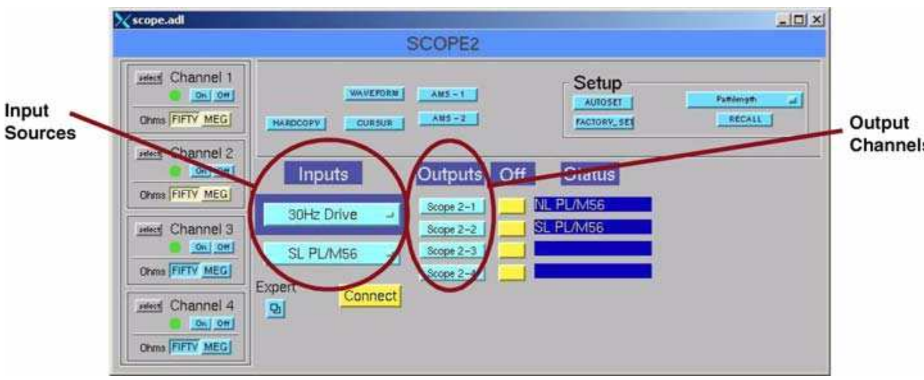

Figure 3: New MEDM remote controls for oscilloscope

Analog signals from the field (e.g., North and South Linac $M_{5,6}$/pathlength, bunchlength, aperture interception) are connected to one of the two oscilloscopes through a 32x32 crosspoint switcher. The crosspoint switcher and the oscilloscopes are remotely controlled through MEDM/EDM screens. The scope's display is piped to the video wall via the Jupiter wall controller. The controller supports the display of up to four RGB devices at one time.[4] An example of the scope display is visible in Figure 2.

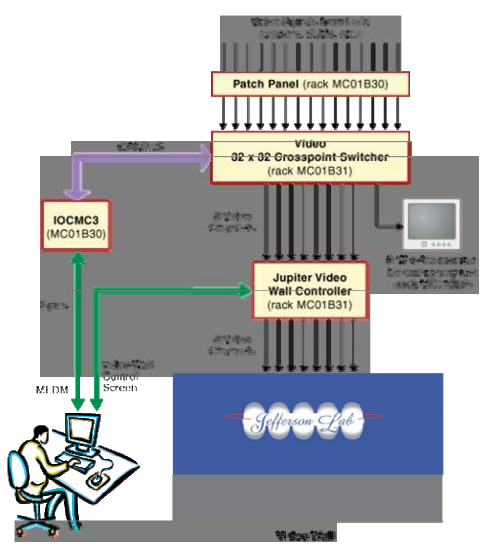

Figure 4: Analog monitoring system simplified block diagram

In addition to using a crosspoint switcher for the traditional analog signals, an identical switcher is used to pipe video from viewers to the display wall. Presently, an operator must go through several steps to insert a viewer, connect to the crosspoint switcher, and configure the Jupiter video display. Development is underway to automate this cumbersome procedure and simultaneously develop a protocol for communication between EPICS and the Jupiter controller.

DISTRIBUTED CONTROL

Various high level applications needed to be redesigned, upgraded and developed in support of the new operations paradigm. Among the application enhancements required were the electronic logbook submission system, the alarm handler, and the automatic Beam Time Accounting (BTA) process.

ELOG Submission

Electronic logbook entries (elogs), Operations Problem Reports (OPS-PRs), and Downtime log entries are presently created by Jefferson Lab's DTLite application. DTLite is a Tcl/tk based data entry tool developed in 1997 for the original electronic logbook. The tool now provides an interface for the database, in the form of problem and downtime tracking. As an interface for the creation of Downtime log entries, the application was traditionally invoked and run on shared consoles located in the middle of the control room. These consoles have been functionally replaced by the large format DLP video display.[5] The elimination of the shared workstations required a new way for operators to maintain long running downtimes (those that span shifts) and at the same time allow multiple operators to contribute to the entry. A new application "dtDisplay" was designed to continuously run on the display wall. The application provided the capability to post an incomplete entry to the display wall where any DTLite user could then check-out the entry and update as necessary. In addition to providing readily available information about current problems, "dtDisplay" tracks the downtime duration and notifies the Crew Chief of escalation action that may be required. The new ability for individual operators to append information and pictures to a single elog entry has been invaluable to the control room.

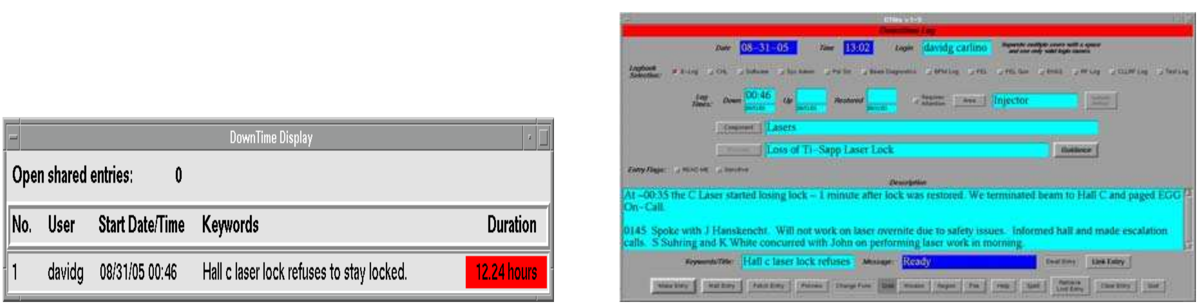

Figure 5: dtDisplay application (left) displaying long running downtime. DTLite (right) after fetching the same incomplete downtime entry.

Alarm Handler

The control room upgrade influence on the EPICS Alarm Handler (ALH) is ongoing. Work is being performed on migrating from version 1-2-10 to version 1-2-16 of the ALH. The latter version includes features that are paramount to the goal of distributed controls. New requirements include global acknowledgement and disabling of alarms, smarter automatic configuration, centralized logging, and a geographical view of the accelerator. These new requirements prompted a thorough review of alarm configuration. This review included the removal of extraneous alarms, reorganization of the alarm hierarchy by geography instead of system, and improved use of previously underutilized features of the alarm handler itself. These configuration changes were able to be implemented while using the older ALH version. The new version of the ALH will be used to fulfill the "globalization" portion of the requirements. When deployed, a master copy of the ALH will be run on a headless workstation to manage the alarm logic, operators can then open copies to globally acknowledge the alarms. The extensive use of FORCEPV and FORCE_CALC statements (ALH 1-2-16) will allow users to globally disable alarms through a new separate application, alhDisable. Enunciation of alarms will no longer be limited to the ALH "chicklets," instead, SEVRPVs will be used to summarize alarm states in EDM screens. Changes to the ALH itself are still underway, namely modifications to the code allowing transparent use of CDEV and development and use of a new keyword UASEVRPV (works like SEVRPV to display unacknowledged alarms). Coupling CDEV with the ALH has required enhancements to the CDEV CA service as well. Upon completion, the service will support "ack" and "ackt" messages and allow unAckSevr and ackTrans tags along with severity, status, etc. Once ALH 1-2-16 has been deployed, the modified version of CDEV will be released and available, and the changes made to the ALH will be submitted for inclusion in new releases. [6]

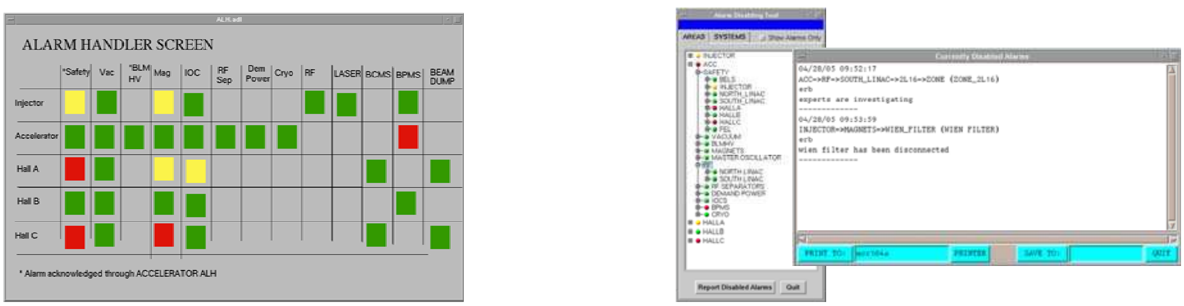

Figure 6: Future of Jefferson Lab's ALH interface. On the left, is an example of an MEDM alarm screen. The figure on the right gives a preview of the new alhDisable tool and report.

Beam Time Accounting

At Jefferson Lab, a performance-based Department of Energy contract means keeping careful track of the time spent sending productive physics beam to the experimenters. Traditionally, this tracking was done by a Tcl/Tk application, created by a former JLab employee, that continuously monitored the state of the accelerator from one and only one shared operator console. The new operations philosophy called for a redesign of this essential tool. The script was divided into four independent entities: a new ioc application to keep track of the time, a server to manage beam state logic, an operator interface to manually set the beam states, and a relational database to store the resultant data. The separation of these tasks has vastly improved the efficiency of the system, not only with regard to the control room upgrade, but the entire time accounting process. Now that the "counting" has been separated from the logic, additional applications such as the "Instant Availability Graphs" have been developed for display on the video wall. This new view of a shift's progress provides immediate feedback as to how well the accelerator is meeting the shift's goals.

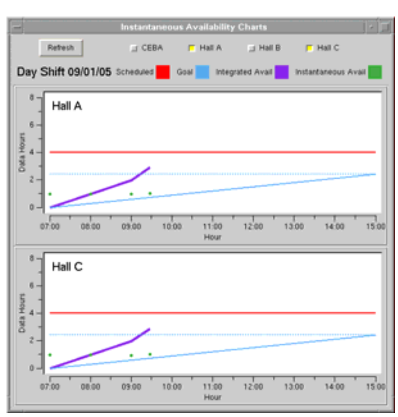

Figure 7: New Instant Availability Graph

CONCLUSION

The idea for a new control room started as a seed planted by a presentation at an international conference and it blossomed into a plan to reinvent the way business is conducted here at Jefferson Lab. Many people worked together to create the new state-of-the-art control room this paper only describes those contributions made by the Jefferson Lab Controls Group. Within the Control Group, everyone from system administrations, to ioc software engineers, to high-level application developers helped to make the dream of a new control room come true.

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[1] "CEBAF Control Room Renovation" M.Spata, T.Oren, A.Cuffe, H.Fanning, TJNAF, Newport News, Virginia, USA. Presented at PCaPAC 2005 Conference, Sakendai, Japan.
[2] "Display Wall Overview" A.Cuffe, TJNAF, Newport News, Virginia, USA. JLAB Internal Document.
[3] "EDM for the Wall Rational" I. Carlino, TJNAF, Newport News, Virginia, USA. JLAB Internal Document
[4] "Oscilloscope-to-Video-Wall Setup Procedure" I.Carlino, T.Oren, TJNAF, Newport News, Virginia, USA. JLAB Internal Document.
[5] "Software Requirements for: Electronic Logbook Input Interface" I. Carlino, TJNAF, Newport News, Virginia, USA JLAB Internal Document
[6] "Alarm Management at Jefferson Lab: A New Configuration and Extended Capabilities" B. Bevins, M. Joyce, J. Sage, TJNAF, Newport News, Virginia, USA Presented at EPICS Collaboration Meeting, Palo Alto, California, USA.

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