REMOTE SHIFTING AT THE CLEO EXPERIMENT

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Abstract

The CLEO III data acquisition was from the beginning in the late 90's designed to allow remote operations and monitoring of the experiment. Since changes in the coordination and operation of the CLEO experiment two years ago enabled us to separate tasks of the shift crew into an operational and a physics task, existing remote capabilities have been revisited. In 2002/03 CLEO started to deploy its remote monitoring tasks for performing remote shifts and evaluated various communication tools e.g. video conferencing and remote desktop sharing. Remote, collaborating institutions were allowed to perform the physicist shift part from their home institutions keeping only the professional operator of the CLEO experiment on site. After a one year long testing and evaluation phase the remote shifting for physicists is now in production mode.

This paper reports on experiences made when evaluating and deploying various options and technologies used for remote control, operation and monitoring e.g. CORBA's IIOP, X11 and VNC in the CLEO experiment. Furthermore some aspects of the usage of video conferencing tools by shift crews are being discussed.

MOTIVATION

High Energy Physics Experiments traditionally are carried out by collaborations which often consist not only of residential but also of national and international member institutions. The inherent distributed structure of collaborations manifests itself in frequent traveling of collaboration members between home institutions and the site where the detector is located to run shifts on the experiment. In the context of the rapidly emerging information technologies the desire for conducting shifts far away from an experiment has increased in recent years.

A second important aspect of collaborations is that building a large scale high energy physics experiment typically splits up in parts. The design, manufacturing and implementation of these gets distributed to remote institutions which have the necessary expertise to contribute the required parts. As a consequence remote institutions are in charge of maintaining and monitoring the specific parts often for the life time of the experiment. To simplify these tasks the detector needs to have remote capabilities for monitoring and troubleshooting subsystems on a software as well as on a hardware level.

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CLEO implemented many remote capabilities when the detector was upgraded to CLEO III [1] in the late '90s and in 2003 to CLEO-c. Next to remotely controllable power supplies and environment sensors for all front end read out crates the software to run the CLEO data acquisition system [2] was designed to be operated from a remote site. Using Java for all graphical user interfaces (Gui) and CORBA [3] for the control and communication layer made this possible. Although not used to a large extent during commissioning of the CLEO III detector these features have been revisited recently.

When the CLEO experiment started to hire professional shifters in early 2001 the coordination and operation of the CLEO experiment was overhauled. Specifically the tasks of the shift crew - two persons at CLEO - were separated into a professional shifter and a physicist shifter one. The professional shifter, also called CLEO operator, is in charge of operating the data acquisition system and various other detector support systems like gas systems or the cooling system. The physicist shifter is responsible for ensuring the physics data quality as well as the detector performance. Both tasks are in general complementary, however some redundancy in critical system variables is built into the shifter procedures.

This logical separation of tasks made it possible to implement the idea of remotely conducted physicist shifts. The hired professional shifters are on site, whereas the collaborating physicists to a large fraction of the year are not. Remote shifts supposed to have several advantages: reduction of travel costs is certainly one, but also it allows collaborators to stay at their home institutions and follow their daily routine while still being able to participate in the ongoing experiment.

The following chapters will illustrate what approaches have been made to make use of existing features of the CLEO data acquisition as well as on how to implement video conferencing tools for detector shifts at CLEO.

IMPLEMENTATION

Tools for the Physicist Shifter

As a requirement for remote shifts the physicist must have the same or at least a comparable tool set available remotely as he would have in the CLEO counting room on site.

Most CLEO data acquisition user interfaces are implemented as Java graphical user interfaces (Gui) or web browser interfaces. One important tool is the Sessionmanager, which acts as a desktop for running all application Guis for monitoring and controlling the detector readout. Another tool is the online event display based on a Tcl/Tk implementation. Both applications - Sessionmanager and event display - are running on site on two PCs located in the CLEO counting room. For monitoring support systems and status information a couple of web interfaces are available complemented by an electronic logbook which is connected to the CLEO operator's main electronic logbook.

CORBA's IIOP–over–HTTP

Since the CLEO III data acquisition system was designed by using Borland's CORBA product suite *Visibroker* [3] as a communication layer between system components, it was obvious to make use of Visibroker's IIOP-over-HTTP gateway. It allows to run CORBA enabled clients by means of a web browser interface connecting to the data acquisition system from basically anywhere.

As shown in Fig. 1 a gatekeeper relays the CORBA calls from within the system environment to the client and vice versa. IIOP is used internally as protocol whereas outside the experiment site IIOP is hooked upon standard HTTP protocol. The client can be either a Java applet running inside a web browser or a native Java application for which the code has to be installed beforehand.

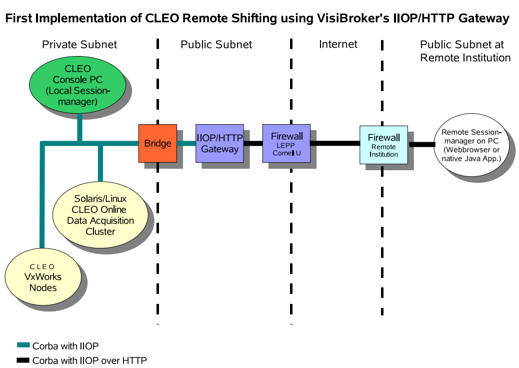

Figure 1: Implementation of remote access to the CLEO data acquisition system by using a CORBA gateway relaying IIOP traffic to HTTP.

X11 and SSH

Instead of utilizing CORBA for the communication to the remote client we also evaluated the old and venerable solution to transfer local displays by means of the X11 protocol. This is in general an easy to set up protocol given the fact that the UNIX platform is well-known and used in High Energy Physics communities. Using X11 applications are a standard procedure at most institutions and universities.

Because all online CLEO data acquisition system computers are located on a private network segment and therefore not visible to the Internet, a gateway connecting both had to be chosen. This gateway was running a local copy of the Sessionmanager and a copy of the online event display. Remote shifters simply logged on to this host using a terminal emulation program based on the Secure Shell protocol (SSH) [6] and forwarded the X11 display to their machine.

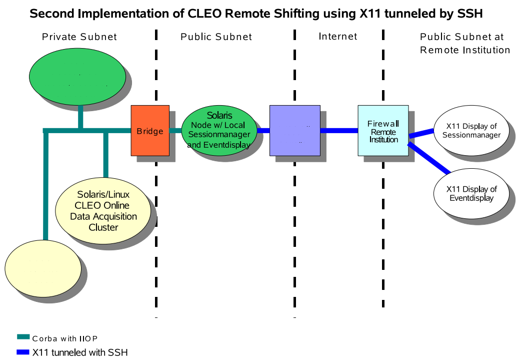

Figure 2: Using X11 protocol to transfer local screen of event display and CLEO online Guis to a remote client host.

VNC and SSH

A third approach – similar to the one before – was to use the Virtual Network Computing (VNC) [7] protocol for transferring local displays. Since two PCs were already used locally for running the event display, on each of them a separate VNC server was installed. For VNC various implementations are available. Next the to original VNC one, RealVNC [7], there's a lightweight version TightVNC [8] available, which is being used at CLEO now.

The VNC server on the PC running the Sessionmanager allows limited operation for starting Gui applications or remote expert control (no program installations are allowed e.g.). The second one displaying the online event display does only transfer the actual screen image but doesn't permit any control of the local PC.

On the remote site several platforms are supported. In general all operating systems for which a VNC version exists are capable of running the remote displays. For Windows 2000/XP the Windows TightVNC version is used together with the terminal program *putty* [9] which enables SSH tunneling for the VNC traffic. On Linux *vncviewer* – part of the VNC package – is used, which has in newer versions a useful option *-via*. This option automatically enables SSH tunneling for VNC. Hence setting up the remote CLEO environment is reduced to an one-line-command for each of the tools and starting up a web browser.

Video Communication

To facilitate communication between the on site CLEO operator and the remote physicist shifter we used a video

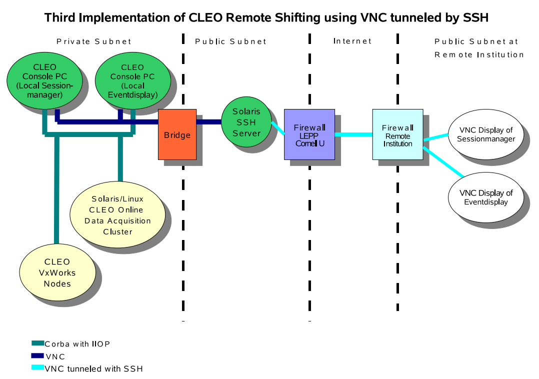

Figure 3: Using Virtual Networking Computing (VNC) and SSH for transferring local operation to the remote client host.

conferencing tool. Though there are a couple of commercial solutions available CLEO decided to go with a in the High Energy Physics community rather popular product named VRVS [4]. This tool is also being used for CLEO collaboration meetings hence there was and is sufficient interest by remote collaborators to establish VRVS at their home institutions.

A standard setup consists of a Windows or Linux PC with Java and VRVS installed. Speaker and a microphone as well as a suitable head set were available on both ends. Mostly off-the-shelves web cameras were used together with the MBone tools VRVS is providing namely VIC and RAT [5].

EXPERIENCES

Technical Aspects

The first approach using Visibroker's IIOP-over-HTTP feature with the gatekeeper would have been the most elegant solution. However when we started deploying CLEO's remote capabilities most of the online data acquisition code was still using Visibroker version 3.x on all three platforms. For these versions the gatekeeper wasn't supporting local firewall configurations very well. Additional packages supporting e.g. SSL are only available with recent Visibroker versions and typically rather complex to configure.

A second issue of the CORBA approach was, that either the native Java code for the CLEO Sessionmanager had to be installed on the remote host or a web browser had to run the Java applet. The latter turned out to be not working sufficiently due to the variety of available browser types. The native Java application worked only after adapting the code to accommodate platform-specific issues. We had no access to the remote machines and relied mostly on the corresponding physicist shifter regarding the installation and troubleshooting process. Remote assistance was often difficult to provide given the fact that most physicists are not necessarily computer experts nor do they the have sufficient privileges and knowledge to install software on their computers.

The solution using X11 was known to be working since this is a standard technique in our community. This was only a temporary solution to explore how well X11 does. Even with dedicated Internet connections running a native Java application on one of the older Solaris nodes required a significant amount of patience by the remote shifter.

VNC is using a compression algorithm which turned out to be excellent for the type of applications CLEO is using. Not only is it easy to setup on UNIX/Linux nodes but also the compression is that good that one can watch the online event display on a standard DSL/Cable modem connection at similar rates compared to those one encounters on the display in the CLEO counting room.

An example view of one of the CLEO remote session is shown in Fig. 4.

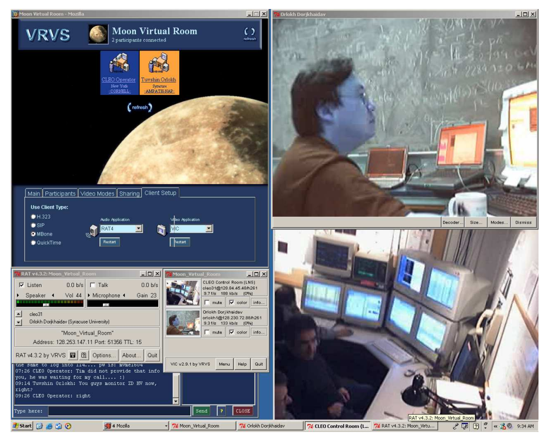

Figure 4: View of the remote site and the CLEO counting room on VRVS.

Firewalls were seen in all tests as a major hurdle especially in case of Visibroker's gateway and the video conferencing tool VRVS. Both needed in early versions a couple of adjustments in the firewall and network setup. Since firewalls are typically in the hands of administrators and computing divisions it wasn't always straightforward for remote shifters to get the tools installed and properly working. Using the SSH tunnel concept was very helpful.

Sociological Aspects

Looking at non–technical aspects of the remote shifting project there are few topics to be mentioned. Physicists in the High Energy Physics community tend to be open to new and innovative ideas, the hired, professional operators are not necessarily. The presence of a web camera in the CLEO counting room irritates professional shifters. Though it has been turned on only during remote shifts, web cameras got taped, disconnected and even hidden in drawers.

As revealed elsewhere in studies on video conferencing the audio channel turns out to be essential. Often the phone is used during setup phases before the actual shift starts. Without the audio channel the remote shifter wouldn't be able to follow the communication of accelerator operators and CLEO operators.

Also one got the impression that communication between CLEO operator and physicist seemed to be more frequent than compared to the CLEO counting room where these persons happen to sit back-to-back.

CONCLUSION

The physicists in the CLEO collaboration welcomed the possibility of remote shifts. It is now in production mode since more than one year and is being used by an increasing number of collaborators. Initial attempts to use a CORBA enabled implementation of remote access were dropped in favor of a more simple and reliable solution using SSH and the VNC protocol.

For running the remote tools used by the physicist it is necessary to have at least two screens, better three at hand to successfully monitor the CLEO data taking process. Improved and more efficient monitoring tools in the future might enable us to run physicist shifts even from a single laptop on the road.

ACKNOWLEDGMENTS

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