VIRTUALLY THERE: THE CONTROL ROOM OF THE FUTURE

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Abstract

Imagine the ILC is up and running. Electrons and positrons collide happily, and scientists are taking data. Suddenly there's a problem with one of the laser wires. All experts are at a meeting on a different continent, but the problem needs to be fixed immediately. Difficult? Not when there's a Global Accelerator Network Multipurpose Virtual Lab (GANMVL) in place. High-speed, high-resolution cameras would allow the faraway experts to look at the fault, a web-based portal would let them access the controls and tools of the system with a simple "single-sign-on" procedure. However, the virtual lab is not just about remote operation. In principle it is already possible to run a control room remotely. This system is radically different in that it takes into account the human aspect of teamwork around the world. The implications of a working virtual control room are enormous. It might revolutionise virtual collaboration in completely different areas. The paper presents the GANMVL tool and the results of the evaluation of the Virtual Lab in production environment and real operations.

INTRODUCTION

The a Global Accelerator Network Multipurpose Virtual Lab (GANMVL) is a tool developed by the EUROTeV project [1], the design study of the International Linear collider [2] (ILC). Imagine the ILC is up and running. Electrons and positrons collide happily and scientists are taking data. Suddenly there's a problem with one of the laser wires. All experts are at a meeting on a different continent, but the problem needs to be fixed immediately. Difficult? Not when you have the GANMVL in place. High-speed, high-resolution cameras would allow the faraway experts to look at the fault, a web-based portal would let them access the controls and tools of the system with a simple and secure procedure.

However, the virtual lab is not just about remote operation. In principle it is already possible to run a control room remotely with different tools. This system is radically different in that it takes into account the human aspect of teamwork around the world. How do you get a virtual team to be as efficient as a real one? Why do we have problems working together over distances when it seems so easy when we're all together? For these questions, the physicists and computer scientists sought the help of two psychologists specialized in human-computer interaction.

One big obstacle is trust, as in a normal working environment you know your colleagues and have a estimate of the level of trust you have in them. In the virtual team, you sometimes have to trust your opposite blindly – people are not happy with that. To take into account this issue the GANMVL team has conducted several interviews and a survey with the different categories of potential users in order to guide the design of the GANMVL tool. The human computer interaction experts have also evaluated the usability of the GANMVL and its components to make them as human-friendly as possible.

The implications of a working virtual control room are enormous. Not only would it make it possible to run the ILC nightshift-free for 24 hours with control rooms in the three regions handing over duty when the next region wakes up. It might revolutionize virtual collaboration in completely different areas, just like the world-wide web developed from a particle physics tool into a thing the world couldn't be without.

The other aspect in which GANMVL is different is its mobility. While other systems only allow access to electronic controls, this one lets the experts operate and collaborate to fix real hardware problems. Technical equipment can be handled and repaired, while the expert does not have to get into a car – or worse, a plane – to fix the bug. Even if there are normally only a couple of people in a control at any time, the accelerator relies on a team of many experts on the various different pieces of hardware.

The most likely scenario of a linear collider or for any large facility is that it will be built by a collaboration of existing laboratories, which will remain involved during the operation of the accelerator.

Prototypes will be developed in one institution and tested with beam in another laboratory. Equipment will be built and delivered by one partner and needs to be integrated into the accelerator complex by another partner. Whole parts of the facility will be provided by a remote partner and need to be commissioned and possibly operated with the experts at their remote home institutions.

In situ trouble shooting and repairs needs to be performed with the support of off-site experts. Advanced means of communication will be necessary to support efficient collaboration.

The GANMVL is a novel collaboration tool to support all these usage scenarios and use cases and can be easily applied to different contexts as it act as an integration platform. The GANMVL is also a good candidate to implement the Global Accelerator Network, a Virtual Organisation (VO) connecting international laboratories doing research in the field of accelerators.

THE GANMVL TOOL

Currently different laboratories provide individual solutions for remote access and monitoring. The GANMVL tool is designed to act as an integration platform providing a simplified and secure solution. Remote operations of an accelerator involve planning of the accelerator operations, maintenance of the accelerator and its troubleshooting, repair of delicate equipment, understanding and pushing performance limitations, performing commissioning and set ups and various routine operations.

The GANMVL tool acts as a mobile communication centre which provides immersive video and audio capture and reproduction of an accelerator control room, a laboratory workplace environment or an accelerator hardware installation.

The tool is able to integrate access to standard measurement equipment (scopes, network analyzers etc.) and to elements of accelerator controls and make these connections available to a remote client.

The remote user should be enabled to participate in accelerator studies, assembly of accelerator components, trouble shooting of hardware or analysis of on-line data as if he or she would be present on site.

Figure 1 describes the GANMVL high level architecture. The user through a web browser access the GANMVL Virtual Organisation (VO) via single sign on. The VO consists of different laboratories each one served by a laboratory server. Each laboratory provides to the VO a set of resources or capabilities. Capabilities are grouped in stations and projects. There is a fine grain control on resources each user is allowed to use.

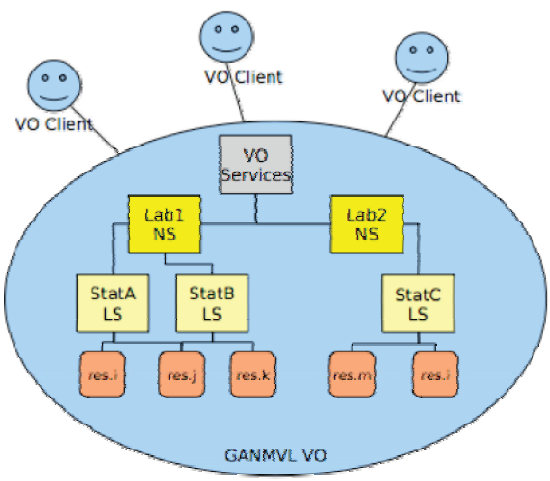

Figure 1: GANMVL Architecture.

Figure 2 provides a more detailed description of the architecture and of the underlying technologies. In particular in order to implement secure access an https tunneling technology has been used. The Web portal interface supports all types of users (remote, laboratory admin, station admin) and all usage scenarios.

A tunneling technology is used to implement secure access to resources and awareness. When the users connects to one of the laboratory server and logs in a tunnel proxy is downloaded. All client applications some of then web based and other native connect to the real resources via tunnels. At the laboratory server the tunnel server handles all the tunnels connecting the clients to the required server. The operators can then use the tunnel monitor to control what is going on and the enable or disable access to resources. Nothing will happen without control and permission of the station operators.

The laboratory server is implemented using the gridsphere framework which runs on tomcat. Comunication and integration with the stations is done via web services. The different resources and capabilities are registered in a capability repository which makes the system extremely modular. The interaction with the real resources requires the laboratory server to execute scripts which are transferred and executed on the specific stations.

Different capabilitites are available to the GANMVL user: high resolution and robotized cameras, file managers, chat, audio and video conference (Skype [7], VRVS [8], EVO [9], …), web based tools like LabView panels, Labview IVI applications to allow integration of instruments, remote desktop tools based on VNC[10] or NX[11] to allow integration of Control Room Panels. New capabilities can be easily added via a plug-in architecture and a distributed component repository.

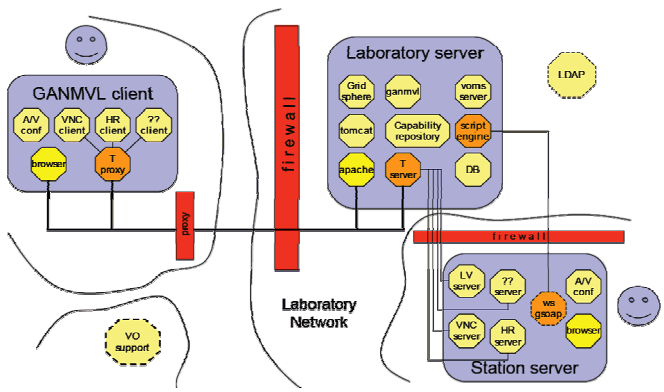

Figure 2: GANMVL Detailed Architecture.

The operator can use wizard to add easily specific instruments and can use a set of knowledge management capabilities like an advanced e-logbook, and a contextual help system. All the available resources can be selected using a resource browser and a contextual toolbox. The toolbox presents all the capabilities associated to the selected resource for which the connected user has been authorized.

The list of people related to the selected resource is available from a people browser. Persons currently on-line are highlighted.

GANMVL AT WORK

The GANMVL is currently installed in different laboratories involve in the EUROTeV project. Different type of stations are available. The control room station is a fixed station in the ELETTRA control room. In this station as you can see in Figure 4, GANMVL is also controlling 2 full HDD 60" LCD screens. Figure 3 presents the GANMVL client connected to the control room station. Other station are available a mobile one implemented using a table PC, an ultra mobile one implemented using a micro-PC. Other stations are connected to a videoconference room and in a training room and among the other things are used to control interactive smart boards. Another station is then used to support on-call persons at the beamlines.

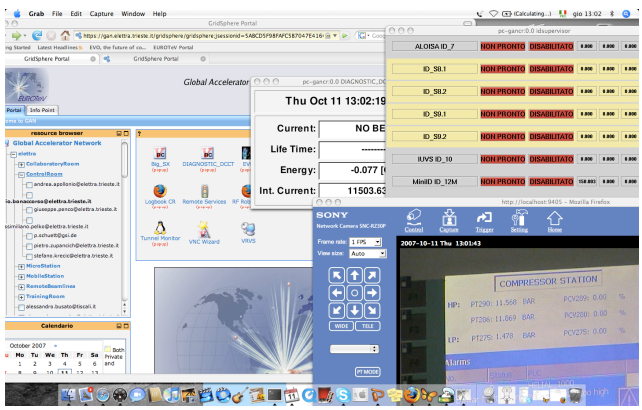

Figure 3: GANMVL at work.

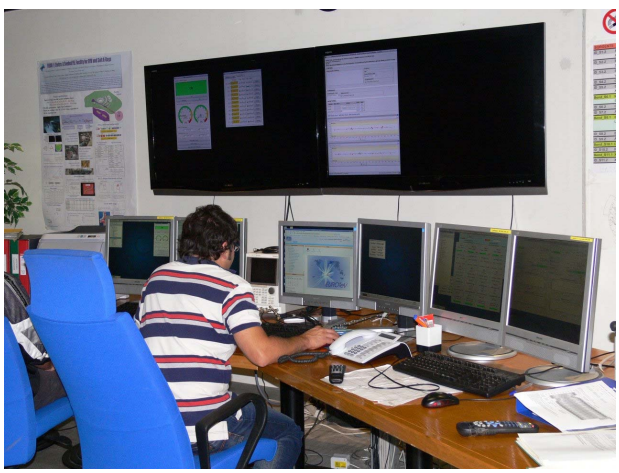

Figure 4: An operator in the ELETTRA control room.

CONCLUSIONS

Remote operations of large experimental facilities is becoming a more and more important issue. The GANMVL tool supports efficiently these application with the necessary level of security while maintaining an high level of usability. Tested in different contexts [3,4] is now used in production in many facilities [5]. The GANMVL tool is now a real integration platform and provides operators and experts with a set of tools that allow collaborative efforts in coping with everyday tasks as well as handling exceptional events.

The GANMVL project provides valuable experience of a new way in designing, building and operating large accelerator complexes, and address the important psychological and sociological issues of the Global Accelerator Network.

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