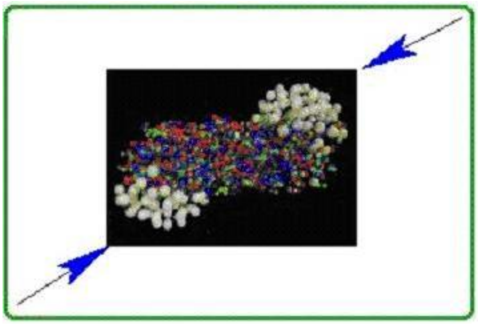

High Energy

High Intensity

Hadron Beams

Proceedings of the 3rd CARE-HHH-ABI Workshop
“Remote diagnostics and maintenance of beam instrumentation devices”
Hirschberg, 6-7, Dec, 2005

Edited by K. Wittenburg[1]

1) DESY, Hamburg, Germany

Abstract

This report contains the final proceedings of the 3rd meeting in the framework of the CARE-HHH-ABI networking, held 6.-7. December 2005, in Hirschberg, with the subject: " Remote diagnostics and maintenance of beam instrumentation devices "

Proceedings of the 3rd CARE-HHH-ABI Workshop
"Remote diagnostics and maintenance of beam instrumentation devices"
Hirschberg, 6-7, Dec, 2005

The European Community wants to reinforce the communication between scientific laboratories of similar nature in the field of high energy high intensity hadron beams. For this reason a so called "networking" program has been defined, which over the next five years will join experts in the field of beam instrumentation and related controls activities. The principle purpose of these meetings is to exchange knowledge on well defined subjects. (CARE-N3 networking for HHH, i.e. for high energy, high intensity hadron beams). These events are not in concurrence with more general instrumentation workshops like DIPAC or BIW.

The third event of this nature is proposed by Kay Wittenburg (DESY), Andreas Peters (GSI) and Hermann Schmickler (CERN) with the following topic:
3rd CARE-HHH-ABI Workshop
"Remote diagnostics and maintenance of beam instrumentation devices"
Hirschberg, 6-7, Dec, 2005

The purpose of the event is:

- to review the objectives and the outcome of previous initiatives on remote accelerator operation or accelerator diagnostics.
- To define realistic objectives for the operation and diagnostics of future hadron accelerators
- to discuss in detail technology issues related to this subject.
- To propose concrete work packages for the coming year in order to meet the specified objectives.

For these objectives we consider important the experience from the major three European laboratories working with hadron beams (DESY; GSI; CERN) and experience from the US.

List of participants:

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Agenda (including links to slides and reports)

1st half day:
The GAN-MVL initiative and others - Introduction
Chair: H. Schmickler (CERN)

- Summary of GAN and GAN-MVLworkshops: Cornell 2002; Shelter Island 2002, Cotogan 2003, Frascati 2005, DESY 2005
  "Towards Far Remote Operation of Large Future Accelerators" ;
  Goal: Extract principle and obstacles (technical or political nature)
  Speaker: F. Willeke --- ***Page 5***
- The user needs – report about the GANMVL user query and the evaluation M. Hodapp, University Mannheim :
  "GAN – MVL User Survey"
  Speaker: P. Schütt (GSI) (in substitution of M. Hodapp)
  "The GAN MVL Project"--***Page 15***
  "Tools for far remote accelerator operation" ------------------------- ***Page 18***
- LHC@FNAL: Report on requirements gathering for remote operation of LHC experiments and read-only access to machine equipment.
  "LHC@FNAL Requirements for Remote Operations" ---------------- ***Page 19***
  Speaker: E. Gottschalk (FNAL)
- *"Workpackage on remote instrumentation handling in the US-LARP collaboration proposal."*, --- ***Page 22***
  Speaker: H. Schmickler
- Round table discussion, spontaneous contributions (e.g. Establish ideas for more GAN-cooperations between diagnostic groups)
  Speaker: all

2nd half day:
Virtual Instrumentation Integration – principles and examples
Chair: K. Wittenburg (DESY)

- Overall Technical Specifications, examples
  "GAN-MVL Overall architecture"--***Page 23***
  Speaker: K. Rehlich (DESY)
- Existing industrial solutions and Concept of Virtual Instruments,
- "*Existing Industrial Solutions and Virtual Instrumentation Integration into GANMVL*" --- ***Page 25***
  Speaker: R. Racher (DESY)
- Round table discussion, spontaneous contributions:
  "CNIC at CERN" by P. Charrue (CERN); ------------------------------- ***Page 29***
  "GAN: remote operation of accelerator diagnosis systems" by M. Werner (DESY); --- ***Page 33***
  "BNL Experience with Remote Diagnostics" by P. Camron ---------- ***Page 35***

3rd half day:
Definition of work packages from the diagnostics view point
Chair: A. Peters (GSI)

- Round table discussion on predefined three topics
  Speaker: all; Summary by A. Peters
- *Remote diagnostics for machine operation* ------------------------------- ***Page 40***
- *Remote maintenance of diagnostic equipment* ------------------------ ***Page 41***
- Preparation of the protocol of the discussion for the proceedings;
  Speaker: all
- Continue establishing ideas for more GAN-cooperations between diagnostic groups
  Speaker: H. Schmickler, all; Report
- Closing Remarks
  Speaker: A. Peters (GSI), K. Wittenburg (DESY), H. Schmickler (CERN)

Towards Far Remote Operation of Large Future Accelerators

F. Willeke, DESY

Outline

- International Collaboration
- Far remote Operation
- Technical Issues
- Sociological Issues
- Organizational Issues
- GANMVL Proposal

Relevance of Global Collaboration for Next Generation Particle Accelerators (NGPA)

General Consensus:

- Particle physics has no broad and comfortable avenue into the future: the spectacular progress of the 60ies,70ies and 80ies have slowed down
- The accelerator facilities required to make further progress are very large and costly
- Particle Physicists are not very successful to explain to society why we need to make further progress in our field
- ➔ IF we want to make progress, we need to combine the world-wide resources for future accelerator projects

How to proceed:

There are two extreme positions of how to proceed:

- Combine all available resources and expertise in one location (Super-CERN)

Advantage: Strong organization and streamlined management possible in order to carry out efficiently large scale projects

- Global Collaboration of the Accelerator Laboratories by contributions to a common project

Advantage: Preserve the existing laboratories with the broad base of grown expertise which can regenerate from a large scientific base, necessary to keep the field dynamic and healthy

Conclusion

Not knowing what the path the field will eventually take, we need to understand the implications of these options:

For Global Collaboration this means we need to study where the real issues are, we need to start collaborations on a small scale, find out what procedures, tools are needed

➔ **This is the motivation for all FRO-Related Studies**

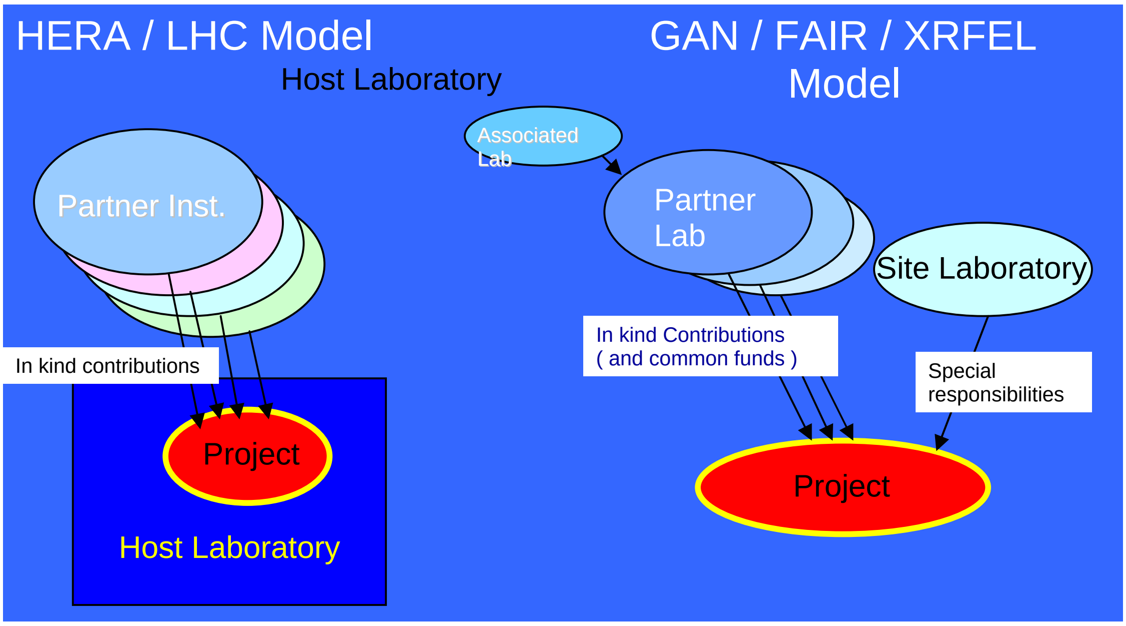


Fig.1 Collaboration Models

The need for Far Remote Operating

If the contribution to the project from remote collaborators is exceeding a certain level, the commitment of the collaborating institutions **beyond the construction** phase in **commissioning**, and **operation** is mandatory, because of the host laboratory will not be able to handle the whole facility with its own staff.

On the other hand, this commitment cannot be made by relocating the technical staff on the site of the accelerator

- ➔ Far remote operating (operating in the widest sense, that is including running the accelerator, performing maintenance, trouble shooting and repairs, tuning-up the hardware systems, maintaining and managing spare inventory, pushing performance,) is required

The implication, the procedures, the technical support of this mode of operation of a large facility must be studied (also experimentally!!) and must be well understood.
➔ This is why we need the "FRO" projects to prepare for the NGPA

Further Considerations

- The symbiosis between competing laboratories with their own cultures, their expertise and particular strengths has been one of the key elements for the success of particle physics and accelerator technology
- Extracting the expertise and combining it in a "world laboratory" at one single site would be a difficult, time consuming task with uncertain success (see SSC)
  ➔

Existing laboratories stay intact and collaborate over long distances building the next large accelerator
"virtual world laboratory"

Choice of Accelerator Site

Agreeing on an accelerator site is a most difficult question to settle for any collaboration

However, since large accelerators are remotely controlled and since one expects further rapid progress and evolution of communication technology in the next decade,
Far Remote Operating should be feasible and could lead to a
➔ **de-emphasis of the importance in the choice of the accelerator site**

Work-Model of GAN

(A.Wagner, ICFA Meeting '99)

- Collaboration is formed by **equal partner institutions** which includes the laboratory at the accelerator site **(''site laboratory'')**
- Each of the main collaborating institutions is responsible for a part of the accelerator complex
- Institutions are collaborating on components to make **best use of existing expertise** for an optimum design
- It is important that the **commitment of partner institutions extends** beyond the building and early commissioning phase
- **Experts** of the collaborating laboratories **remain based at their home institution**
- Collaborating laboratories are **involved in all aspects** of accelerator design, building, commissioning, operating

Experience from the SLC, LEP HERA:

the LC is expected to be in a state of continuous commissioning and improvement
How to assure commitment beyond the construction and first commissioning of the parts contributed by the various laboratories?
➔ **Need to keep the off-site designers and experts involved and interested**
  ➔ They need to be part of the team, which operates, trouble shoots, improves and pushes performance of the accelerator
  ➔ Collaboration beyond design and construction phase via
Far Remote Operating

Recent Progress towards GAN and LC

1999

- First Discussions between SLAC and DESY on Far Remote Operating

- A. Wagner proposes GAN at ICFA

2000

- ICFA initiates two taskforces to explore the managerial and organizational aspects and the technical implication of Far Remote Operating
- ICFA initiates a new term of the Loew Panel for technical review of the linear collider projects

2001

- Report of the Taskforces: no technical show stoppers but main difficulties in management, sociology and organization
- Discussion of Far Remote Operation in Accelerator Community ➔ Large resonance
- International and European LC Steering groups initiated

2002

- GAN Workshops: March in Cornell, September near BNL
- Loew Panel presents its report
- Proposal on possible ways to collaborate on TESLA submitted as part of the TESLA proposal
- Working Group on Remote Accelerator Operating within the ICFA BDP initated
- GANMVL Proposal as part of the ESGARD endorsed Linear Collider Design Study

Proposal within the 6th Frame Programme of the EU

- GOTOGAN, the 3rd Workshop on GAN

2003

- ILCDG: 3 Regional Linear Collider Design Groups
- technology recommendation in favor of cold RF technology
- ILC, Design Effort constituted, 1st ILC Workshop

2004

2005

- 2nd ILC Workshop, preparation of the CDR

ICFA Study Groups on an accelerator facility which is designed and built in collaboration and is far remotely operated and maintained (2000-2001)

Group 1
Management, Organizational and Sociological Aspects of
(chair: Allan Astbury, TRIUMF)
Group 2
Technical, Organizational and Sociological Aspects
(chair: F. Willeke, DESY)

Conclusions of ICFA Taskforce 1

chaired by Allen Astbury

General: A participation in GAN may not be sufficient to keep a laboratory alive,
developing adequate organizational models will be difficult,
sociological aspects are important

- GAN model based on in kind contributions from partners

- Collaborating must be able to maintain strong control
- need to keep number of partners small: channel contributions through big laboratories
- Next to in-kind contributions in components collaborators need to contribute cash funds
- Site Laboratory: special task of providing infra structure (no green field site)
- Important to involve partners in the design stage
- Project leader position compared to spokesman of high energy experiment

ICFA Taskforce 2 Conclusions

- Extrapolation of present large accelerators to GAN-like environment looks encouraging
- Experience on far-remote operation of telescope is an existence proof that there are no unsolvable technical problems
- Networking and controls technology at today‘s level is already sufficient for needs of remote operations
- Diagnostics in hardware must be sufficiently increased, this must be taken into account in the early stage of a design (obvious), major challenge of hardware design is reliability, which is independent of GAN
- Challenge lies in organization of operations, maintenance, communication, need formalized procedures, need dictionaries and formal use of language, development of communication tools

Experience from HERA, LEP, SLC...

Maintenance, Trouble Shooting Repair:
essentially **“REMOTE FACILITIES**”,:

- problems diagnosed remotely before intervention,
- interventions by **non-experts** successful in 90% of the cases,
- experts help via telephone suffices or via remote access
- unscheduled presence of experts on-site is an exception

Remote Operating with the ESO Remote Telescopes

CAT and NTT telescopes operated from Garching

- remote access to the site computer network (*limited to upper level of the control system)*
- networking based on lab’s own 12-14GHz satellite connection
  rate of 0.7Mbit s-1 : >sufficient for operating & acq. experimental data
  Dt=450ms sufficiently fast for videoconference transmissions

Cheapest, best operational safety & stability (at the time)

Remote Experience

Remote operations Garching-La Silla: no technical problems.
Remote trouble shooting but Repairs& tuning on complex mechanics
Performed routinely remotely by experts on site
experts relocated on site increased their efficiency (30% → 5%)
expert crew on site, remote operations lost its attractivity.

CAT lifecycle : operated remotely from Garching,
NTT telescope : was operated locally after
control system modernized. the site in Garching became incompatible.

Commissioning of new telescope always by experts on site.
emergency stops and similar safety features hardwire

Recent Examples for Far Remote Operation

- *TTF capture cavity was operated and maintained in the commissioning phase by SACLAY (1998-2000)*
- *TTF operations from MILANO (2000/2001)*
- *Fermilab Photo Injector Studies from DESY*
- *SNS injector Studies at the LBL build injector at Berkeley (2002)*

Accelerator Controls

Control systems layered approach, adequate,
Control Room Segment < 10Mbit/s
fast feedback loop confined to hardware environment
analog signals replaced by digital technology
➔ Remote trouble shooting routinely performed
➔ Experience Available in Remote Console Operation

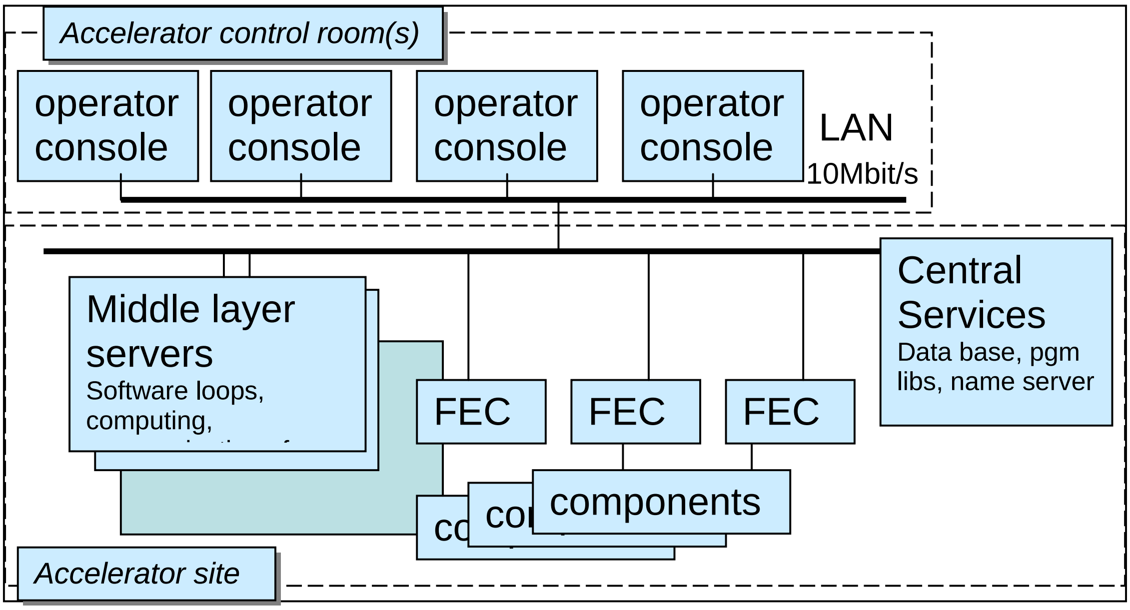


Fig. 2: accelerator control rooms

Flexible Diagnostics

Example from HERA re-commissioning in 2001
Operations and tests from remote control center
Few but **important** exceptions:

Example: Inspection of BPM analog signals with fast scope to steer beam through an IR with a broken magnet (could be diagnosed only by „steered through" beam)

Hardware Requirements

On-site, majority of repairs => exchange of modules.
=> *Components be composed of modules Reasonable transportable size, Easy to restore interfaces*
Requirements essentially identical for **ANY** large complex technical facility.

- Redundancy of critical parts, (costs!)
- Avoidance of single point failures
- Comprehensive failure analysis,
- Over-engineering of critical components
- Standardization, Documentation:
  design procedure & components & quality assurance
- avoidance of large DT, thermal stress,
- Control humidity and environmental temperature extremes.

Specific features connected to remote operation **(additional costs reasonable**)
High modularity
ease troubleshooting & minimize repair time,
Complete Remote Diagnostics **CRUCIAL!**
Simultaneous Operation & Observation.

Model for a Remote Facility

- Collaboration of Equal Partners (no **"host"** laboratory but "**near-by**" laboratory)
- Facility **far away** from most Collaborating institutions
- Each collaborator responsible for **major section** of the machine incl. subsystems *design, construction, commissioning, maintenance, trouble shooting, development*

  Collaborators remain responsible for the part they contributed after construction
- Experts remain based at the home institution

  Most of the activities via **remote operating and remote access**
- **Central Management** responsible for the over-all issues, *performance goals, design, interface, schedule, quality control, standards, infra structure, safety*
- Operation **centrally organized**: *planning & coordination, commissioning, operation, maintenance, machine development*
- Operation performed by **decentralized operations** crews

Model for Remote Operations

- Central board supervises operations
- there is always **one control center** responsible for the entire complex
- *handles operation commissioning, routine operation for physics, machine development studies, ongoing diagnosis, and coordination of maintenance, repairs and interventions*
- resides at **different, but identical control rooms** at the collaborating institutions
- operating is performed by **remote crews**

- Control will be **handed off between control rooms** at whatever intervals are found to be operationally effective.
- **Supporting activities** may take place at the other control centers **if authorized** by the active control center.

Model for Remote Maintenance and Trouble Shooting

The collaborators remain responsible for the components they have built
must provide **an on-call service** for remote trouble shooting to support current
operations crew (can authorize intervention)

An **on-site crew** is responsible for exchanging

- *putting components safely out of operation,*
- *small repairs,*
- *disassembling a faulty component or module and*
- *replacing it by a spare,*
- *assisting the remote engineer with diagnosis,*
- *shipment of failed components to the responsible institution for repair,*
- *maintenance of a spares inventory,*
- *putting the component back into operation*
- *and releasing the component for remotely controlled turn-on and setup procedures.*

**Decions about planned interventions by the operations board
in close collaboration with the laboratory responsible for the
particular part of the machine.**

Cornell Workshop March 21-23 02: Enabling the Global Accelerator Network

Goal: ***Start the discussion in the community on the needs for controls and communication for a GAN***
Proposed view point: Participate in a Linear Collider Project as a non-local collaborator

- Working Group 1 Elements of a Global Control System

- Working Group 2 Tools for Implementing Control Systems

- Working Group 3 Communication and Community Building
- 42 Participants from Cornell, LBL, CLEO, JLAB, DESY, FNAL, SNS, ARECIBO, BNL, SLAC, CEA, KEK, RAL, SPARC

<u>**General Impressions**</u>

- Very open discussion and constructive atmosphere
- Surprising amount of consensus among participants
- Very interesting interactions with communications scientists

Shelter Island
September 17-20 2002

3 Working Groups:

- Far Remote Operating Experiments
- Remote Operating Tools
- Hardware Design and Maintenance Organization Aspect

European Design Study Towards a TeV Linear Collider
WP 8:Multipurpose Virtual Laboratory for the Global Accelerator Network

European Institutions who have expressed interest in participating in **GANMVL**

- DESY Hamburg (F. Willeke, D. Trines, D)
- GSI (N. Angert, P: Schuett, S. Richter D)
- Frauenhofer Institiution (M. Einhoff, IGD)
- INFN Milano (D. Sertore, I)
- University Rom2 (S. Tazzari, I) TTF
- Elletra, Trieste (R. Pugliese, I)
- Universidad di Udine (L. Chittaro, HCI, I)
- Universität Manheim (W. Bongardt, Inst. for Psychology, D)

Interested Institutions outside Europe

- **Fermilab Photoinjector Facility (H. Edwards)**
- **Cornell University (M. Tigner)**

WP 8 Test of Global Accelerator Network using a Multipurpose Virtual Laboratory (GANMVL)

Most likely scenario of LC: built and operated collaboration of existing labs, Advanced communication tools necessary to support efficient collaboration.

GANMVL will design and build a novel collaboration tool and test in on existing accelerator collaborations ➔ mobile communication centre

- **immersive video and audio capture of labs, CR, Service Bld's**
- **connect to standard measurement equipment**
- **connect to accelerator controls**
- **visualize and make connections available to a remote client.**

remote user enabled to >> participate in accelerator studies,
>> assembly of accelerator components,
>> trouble shooting of hardware or
>> problem analysis

The GANMVL project will provide valuable experience of a new way in designing, building and operating large accelerator complexes.

COTOGAN Workshop Trieste

- About 40 participants
- Mixture of experts from the major accelerator laboratories in Europe and the US, Human-Computer Interface Study Groups, Fusion Community, HEP Experiments

- MAIN-TOPIC: Collaboration Tools, criteria and requirements for the MVL Tool, MVL User needs

Innovative Aspects State of the Art

Accelerator control systems handle complex accelerator operations and development programs, troubleshooting, comprehensive data logging on time scales ranging from microseconds to years.
Missing: platform independence, uniform nomenclature, formalized used of language, and most important mutual awareness of distributed remote users.
Virtual instruments are commercially available, but there is no uniform approach.
missing is a plug and play mechanism, which recognizes all the instruments, connected to the system and automatically and makes them automatically remotely available.
IP-based desktop and 3-D video and audio communication are fast developing technologies with a huge market. The available systems however are based on obsolete technology, which does not fully exploit available technology.
Missing 3-D visualization is at present depending on wearing inconvenient devices, facing of video communication partner, adaptive video-encoding/decoding

Conclusions

- There is consensus to build the next large accelerator, LC in a collaborative effort which goes beyond the HERA model

- The idea of Far Remote Operations has widely accepted now in the accelerator community, in particular also in the non-LC part of the community (LHC, SNS,…)

- The two GAN workshop produced a number of ideas and useful interactions with communication scientists

- What is needed now are more serious steps:

➔ a genuine far remote operating experience beyond turning knobs far remotely
➔ progress in defining appropriate organizational models for GAN
➔ development of well tailored communication tools

THE GANMVL PROJECT

P. Schütt*, GSI, Darmstadt, Germany
M. Hodapp, Chair for Business and Organisational Psychology, University of Mannheim, Germany
R. Pugliese, ELETTRA, Trieste, Italy
R. Ranon, HCI Lab, Department of Math and Computer Science, University of Udine, Italy

Abstract

The most likely scenario of a linear collider is that it will be built by a collaboration of existing laboratories, which will remain involved during the operation of the accelerator. Advanced means of communication will be necessary to support efficient collaboration. GANMVL[1] is a project which will design and build a novel collaboration tool and test it on existing accelerator collaborations. GANMVL is the acronym for "Global Accelerator Network Multipurpose Virtual Laboratory". The tool is 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. It is able to connect 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. The GANMVL project will provide valuable experience of a new way in designing, building and operating large accelerator complexes, and will address the important psychological and sociological issues of the Global Accelerator Network.

HISTORY OF GAN

In August 1999, DESY Director Albrecht Wagner proposed at the ICFA (International Committee on Future Accelerators) Meeting at Fermilab "A global collaboration between the large accelerator laboratories to build a linear collider in close collaboration". This Collaboration was to be referred to as "Global Accelerator Network" or GAN.

In February 2000, ICFA set up a two taskforces on issues of a global collaboration to build a linear collider: Taskforce I (chaired by Allen Astbury, Triumf) discussed general considerations and implementation. Taskforce II (chaired by F. Willeke, DESY) worked on the technical aspects of a global collaboration to build a linear collider.

Taskforce I conclusions were: The GAN model is new for building accelerators, although similar models have been in use to build large experiments for many years. Carrying over the procedures for building large detectors is not trivial: Experiment coordination is usually based on consensus and peer pressure, while the accelerator departments have a clear hierarchical structure. An accelerator laboratory needs on-site activities to maintain culture and vitality. The site laboratory, where the collider is finally built has to take over the special task of providing infrastructure. Finally, it is important to involve the partners in the design stage.

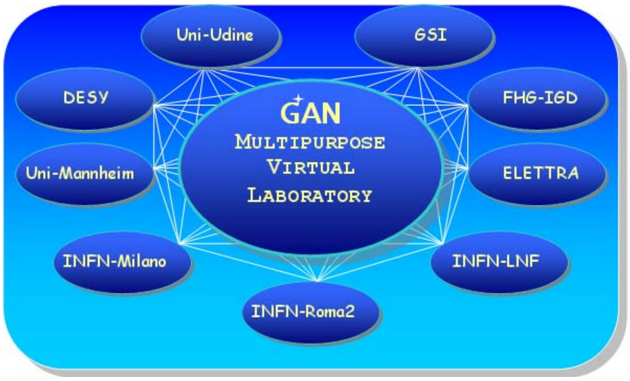
Taskforce II asked: Can we build, commission and operate a large accelerator facility with the contributing labs remaining committed to their part of the project, without any major relocation of staff, thus by means of remote operation in the most general sense?

And it concluded already in this early stage: The extrapolation of present large accelerators to a GAN-like environment looks encouraging. The experience on far-remote operation of telescopes is an existence proof that there are no unsolvable technical problems. Networking and controls technology at today's level is already sufficient for needs of remote operations. Diagnostics in hardware must be sufficiently increased; this must be taken into account in the early stage of a design. The major challenge of hardware design is reliability, which is independent of GAN.

The challenge lies in the organization of operations, maintenance, communication; we need formalized procedures, dictionaries and a more formal use of language. Finally, the development of communication tools is mandatory.

PROJECT SCOPE

Accepting this challenge, the GANMVL collaboration was formed.



Main objectives of the GANMVL project are:

- Support any kind of collaborative efforts on accelerator research
- Define and test procedures for a global accelerator network

---

*Presenting the project for the GANMVL collaboration.

- Assess the sociological aspects of close collaboration in a remote facility

We will design and build a collaborative tool for far remote observation and/or far remote control of accelerator components or experiments at accelerators. This tool will integrate

- state of the art audio- and video communications technology
- virtual instruments
- accelerator controls
- and file and information sharing

into an all round communications tool. This will be implemented as a compact and transportable hardware set-up containing

- 3D-video screens,
- audio devices, video capturing devices,
- computer terminal,
- sockets for connecting network, instruments

THE USER SURVEY

One of the main objectives of GANMVL is to assess the sociological aspects of remote cooperation: assuming that technically we can work together with a colleague in a far remote office; do we really want to do that? How does it change our daily work in a control room?

Two of us, Markus Hodapp (Business and Organisational Psychology) and Roberto Ranon (Human Computer Interface Lab) will observe the impact of the GANMVL tool as well as the acceptability etc.

With a first user survey, we aimed at:

- making the community aware of our work
- assessing acceptability of MVL (as envisioned)
- getting feedback about planned/missing features and their importance
- pointing out issues which need to be recognized and properly taken care of (e.g. social / organizational challenges)
- getting suggestions/ideas from previous related experiences

We asked approx. 600 potential users of GANMVL, accelerator physicists as well as operation and controls people to fill a query. Some 20 % of them answered. This is a normal percentage, but when interpreting the results, we have to keep in mind, that probably users with a negative attitude towards the idea of remote operation did not answer at all.

Experience with Previous Collaborations

The users seem to have good experiences with trust in the professional background of the participating colleagues. This is very important for the acceptance of the collaboration tools the project will develop. In some projects, responsibilities weren't clearly defined. This results in a potential need for assistance in project management. This could be guidelines for the implementation of collaborative projects using MVL, proposals for workshop designs, or implementation of project management tools within MVL.

The main forms of communication in previous collaborative projects seem to be face-to-face and email communication. There are nearly as much users that rate telephone and video conferences important in previous projects as users that rate it as unimportant. Instant messaging and chat were mostly unimportant. Electronic communication tools (e.g., videoconference, mail, chat) were more used by accelerator user, operators, and physicists, and less by other users; we can thus hypothesize that these tools are perceived to be more useful for "routine" work, and not perceived to be useful (or not well known) in design / planning / management activities. As long as communication within MVL would be based very much on video conferences and chat, these features should be implemented as user friendly as possible reducing the needed knowledge and experiences to use it. There seem to be some concerns regarding the technical implementation (technical difficulties, lack of technical competencies/equipment). This could result in a solution with lower technical demands to the client system. This could also result in an intelligent help system guiding new users through MVL.

Finally, data and/or video sharing seems to have been useful for some users. The potential users seem to have relatively good experiences with comparable projects. Based on these experiences, the majority seems to be willing to use the system as host or as expert. In addition, the idea of developing a communication tool to enhance communication is perceived as very useful.

Supported Activities

A list of proposed activities was given as follows:

- Assembly of accelerator equipment
- Setting up a test
- Test of new equipment or entire accelerator
- Commissioning of equipment or entire accelerator
- Equipment maintenance
- Trouble shooting
- Remotely assisted repair
- Accelerator studies
- Tune-up of components
- Tune-up of accelerator beam parameters

From the list, users seem to perceive the more “hardware-sided” activities as unimportant. It is unclear if users can imagine how activities like assembly of accelerator equipment or equipment maintenance can be supported by MVL.

Moreover, users seem to perceive MVL as more useful in accelerator maintenance and routine operations, and less useful in design and testing of new equipment; this is also restated by some free comment at the end of the survey.

Users perceive MVL as a reasonable and not too ambitious project. The willingness to use the tool seems to be high.

Cooperation with Off-site Experts

In principle, remote cooperation between experts and control room operators with MVL is perceived as positive. There are some concerns about problems with not speaking the same mother tongue. In addition, there should be some face-to-face meetings on-site to get to know the accelerator and the staff there.

The only critical aspect seems to be the observation of control room operators with cameras. If this feature will be implemented, there should be a mechanism that allows observation only by permission of the observed operators. There are also legal aspects in some countries that have to be considered.

Elements of MVL

In general, video, audio and mobility of the solution seem to be important. The only critical point in this part seems to be that 3-D audio is perceived by some participants as not important. Corresponding to that, there are some remarks about the technical implementation. Some users would prefer a more simple and stable tool instead of implementing “fancy” technical features.

From free comments at the end of the survey, it seems that some users fear that MVL, in the effort of unifying different functions into a single tool, will be technically obsolete in a few years (i.e. it will be difficult to integrate upcoming technologies). Some users fear also that the project may be too ambitious or is considering a too wide set of functionalities, and suggest the MVL should, at the beginning, concentrate on a few functionalities and test them.

It seems that many users are interested in video / application / desktop / pointer sharing (i.e. tools for synchronous collaboration). This may suggest that we should focus on usage scenarios of synchronous communication / collaboration.

Other users point out the availability of help / system experts. Again, it seems that a well-designed and effective help functionality (either provided by the system or human experts) could be an important aspect of the system.

Remote Access to Accelerator

Safety is perceived as an issue; according to users, the project should investigate to point out clearly what MVL will do with respect to safety on the accelerator site. Simply allowing remote users to observe is not perceived as a good solution (too limiting?), but security / safety mechanisms are needed.

Benefits of MVL

Wider availability of experts (and generally, wider participation) is perceived as the greatest benefit. Another aspect (which is not so typically brought to justify distance collaboration tools) is the social benefits of reduced traveling.

In general, users trust (but not completely) that MVL will give them these benefits.

FIRST TEST OF PILOT

A pilot version of the GANMVL tool was already prepared and implemented by Roberto Pugliese et al based on the ELETTRA Virtual Collaboratory (EVC).

Far remote Operation of ELETTRA involves:

- maintenance, trouble shooting and repair
- machine physics experiments
- commissioning and set-up

All these activities are based on large amounts of information, which are usually accessible only at the accelerator site. Therefore, this pilot gives a good opportunity to test design ideas for GANMVL.

A first test experiment was accomplished on Monday, May 9th, 2005[2]. Using the GANMVL-Pilot, an Elettra Injection-Cycle was performed by an untrained operator (F. Willeke) in his office at DESY, Hamburg, guided through the system by the ELETTRA chief operator on duty (E. Karantzoulis).

Everything worked fine due to the excellent Elettra operation software, and the well functioning MVL set-up. Communications were eased by the fact that the participants of the test know each other well from a previous working relationship.

OUTLOOK

The next steps will be to develop and implement a prototype and systematically test it in various control rooms, thereby iterating the design based on real world experience.

ACKNOWLEDGEMENTS

GANMVL is a work package of EuroTeV project and is a collaboration of colleagues from DESY, ELETTRA, Fraunhofer-IGD, GSI, INFN-LNF, INFN-Mi, INFN-Ro2, and the Universities of Mannheim and Udine.

This work is supported in part by the Commission of the European Communities under the 6th Framework Programme "Structuring the European Research Area", contract number RIDS-011899.

REFERENCES

[1] https://ulisse.elettra.trieste.it/mvlgan
[2] http://www.lightsources.org/cms/?pid=1000540

Tools for Far Remote Accelerator Operation

P. Schütt, A. Peters, H. Tang, GSI, Darmstadt, Germany

Abstract

The most likely scenario of a next generation linear collider as well as for FAIR is that it will be built by a collaboration of existing laboratories, which will remain involved during the operation of the accelerator. Advanced means of communication will be necessary to support efficient collaboration in the design and construction phase as well as far remote accelerator operation.

The GANMVL Project

GANMVL[1], the "Global Accelerator Network Multipurpose Virtual Laboratory" is a work package of EuroTeV[2], the European design study towards a global TeV Linear Collider. It is a collaboration of colleagues from DESY, ELETTRA, Fraunhofer-IGD, GSI, INFN-LNF, INFN-Mi, INFN-Ro2, and the Universities of Mannheim and Udine.

The goal of the project is to design and build a novel collaboration tool and test it on existing accelerator collaborations. The tool is 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. It is able to connect to standard measurement equipment 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.

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

Development of Prototypes

The present specification of the GANMVL tool is based on a world wide query of the user needs. About 170 accelerator scientists and engineers contributed in this query.

The MVL system is envisioned as a client-server system. The server is providing the information from an on-site activity as well as software tools for uploading, safety algorithm, authentification and authorization procedures and help information for a remote user or client.

On the client side it is assumed that any computer terminal equipped with commercially available audio and video equipment is sufficient. The access to control system is accomplished by a thin client technique which is based on a web service in order to be as platform independent as possible.

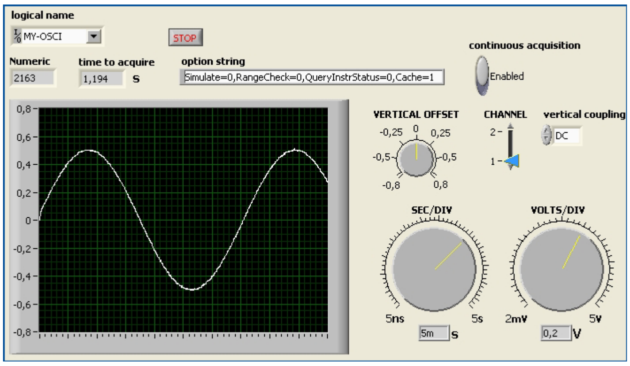
Three prototypes of the MVL server will be built to serve different types of application:

- a mobile server for work in the accelerator tunnel or other restricted areas
- a semi-mobile server for work in laboratories, electronic rooms etc.
- stationary server in control room for operation and commissioning or for observation of equipment behaviour.

Virtual Instruments

In 2005, the contribution of GSI was concentrated on the integration of virtual instruments into MVL based on a plug-and-play mechanism. The goal is to provide interfaces for most of the common off-the-shelf test and measurement (T&M) instruments such as oscilloscopes or spectrum analyzers.

Analysis of the problem led to the conclusion to base the first prototype on the IVI (Interchangeable virtual instruments) standard with generic instruments. A large number of devices are supported by this standard. The prototype version has been implemented and first tests with existing instruments are under way.



logical name: MY-OSCI
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option string: Simulate=0,RangeCheck=0,QueryInstrStatus=0,Cache=1
continuous acquisition: Enabled
vertical coupling: DC
SEC/DIV: 5m s
VOLTS/DIV: 0,2 V

Figure 1: Screenshot of Virtual Instrument Prototype.

Acknowledgements

This work is supported in part by the Commission of the European Communities under the 6th Framework Programme "Structuring the European Research Area", contract number RIDS-011899.

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[1] https://ulisse.elettra.trieste.it/mvlgan
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LHC@FNAL Requirements for Remote Operations

Erik Gottschalk for the LHC@FNAL Task Force

LHC@FNAL is an operations centre to be located at Fermilab. The purpose of this centre is to help members of the Large Hadron Collider (LHC) community in North America contribute their expertise to LHC activities at CERN, and to assist CERN with the commissioning and operation of the LHC accelerator and CMS experiment.

As an operations centre, LHC@FNAL has three primary functions. First, it is a place that provides access to information in a manner that is similar to what is available in control rooms at CERN, and it is place where members of the LHC community can participate remotely in LHC and CMS activities. LHC@FNAL provides a location with hardware and software that is similar, if not identical, to what is available at CERN. For instance, one can imagine that it will be equipped with accelerator consoles that are identical to consoles at the CERN Control Centre (CCC), so that monitoring software that is used at the CCC can be used for long-distance monitoring of components of the LHC accelerator and its subsystems. Furthermore, LHC@FNAL will have safeguards in place to satisfy CERN safety, as well as CERN computing and networking security standards.

The second function of LHC@FNAL is to serve as a communications conduit between CERN and members of the LHC community located in North America. The need for communication is expected to be bi-directional. On the one hand, LHC@FNAL can respond to requests from CERN to locate US-CMS or LHC experts and establish a communications link between these experts and CERN. On the other hand, LHC@FNAL can respond to requests from experts who need access to information that is inaccessible to individuals at home or their home institution. For example, access to some information may require special access privileges or specialized software, or may require verbal communication with someone working at a control room at CERN. LHC@FNAL can provide access to this information, and can relay information to the CCC and CMS control rooms using established communications channels.

The third function of LHC@FNAL is outreach. With accelerator and experiment consoles that replicate systems at CERN and shift operators actively engaged in LHC activities, visitors to Fermilab will be able to see firsthand how research is progressing at the LHC. Visitors will be able to see current LHC activities, and will be able to see how future international projects in particle physics can benefit from active participation in projects at remote locations.

LHC@FNAL is expected to contribute to a wide range of activities as the LHC is readied for operations. For CMS there are test beam activities, the Magnet Test Cosmic Challenge, detector commissioning, and operations. For LHC, activities include training for accelerator physicists so they are familiar with the control system before traveling to CERN, and remote participation in hardware commissioning for U.S. deliverables, LHC beam commissioning, and post-commissioning activities. Post-commissioning activities include remote participation in LHC machine studies; support of U.S. provided deliverables, including continued support from the designers of beam-related equipment during LHC operations; and work on luminosity upgrades. The following list shows activities that we envision for LHC@FNAL:

- Participate in CMS and LHC shifts
- Participate in CMS and LHC data monitoring and analysis
- Develop and test new monitoring capabilities
- Provide access to data, data summaries, and analysis results
- Provide training in preparation for shift activities at CERN
- Assist in establishing communications between accelerator and detector experts in North America and CERN

An important aspect of LHC@FNAL is that accelerator and detector experts will be in close proximity to each other while participating in activities at CERN. The advantage of this arrangement is an economy of scale. Individuals working together on LHC and CMS activities can use the same resources in their work while sharing their insights on the commissioning and operation of the LHC accelerator and CMS experiment.

To develop requirements for LHC@FNAL we had to make assumptions on how accelerator and detector experts in North America will interact with CERN and CMS staff. These assumptions are presented along with scenarios that were used to develop requirements in a preliminary requirements document:

http://docdb.fnal.gov/CMS-public/DocDB/ShowDocument?docid=165

In this document there are two types of requirements: those that address physical aspects of an operations centre, and those that pertain to agreements and policies that need to be addressed by CERN, Fermilab, CMS, and LARP management. Requirements are presented in four sections. The first two sections list requirements that pertain exclusively to CMS and LHC, respectively. Requirements that are common to CMS and LHC are in the third section, and requirements that are derived from constraints such as safety, security, and software development constraints are in the fourth section. The requirements address general capabilities; access to LHC and CMS data, meetings and other types of information; software and software development; the LHC@FNAL operational environment; and computing, networking, software development, security and safety constraints. The preliminary requirements document was submitted to Fermilab’s Director at the end of July, 2005.

Since the submission of the preliminary requirements document to Fermilab’s Director, the LHC@FNAL task force has visited nine sites to learn about the design and layout of control rooms. Some of these control rooms involve remote operations capabilities. We visited the following sites: remote control room for the Gemini Observatory, control room for Jefferson Lab, Space Telescope Science Institute and NASA’s Goddard Space Flight Center with control rooms for the Hubble Space Telescope, National Ignition Facility, General Atomics, Spallation Neutron Source, Advanced Photon Source, and the European Space Operations Centre.

In addition to site visits the task force has initiated a three-month evaluation of a web collaboration tool (http://webex.com/) that provides easy access to a secure environment for sharing data, documents, presentations, and software applications among remote participants. We believe that this type of collaboration tool improves communication and augments existing forms of communication such as video conferencing, telephone calls, and email.

The site visits and ongoing evaluation of collaboration tools have played an important role in developing a plan for LHC@FNAL. Our current work is focused on completing the requirements document by the end of calendar year 2005, along with a resource loaded schedule for the construction of LHC@FNAL. Work on the physical layout of LHC@FNAL has started. In 2006 we expect to complete the design of the operations centre and look forward to begin the construction phase towards the end of the year.

Proposal of “Remote Diagnostics” in the original US-LARP collaboration proposal

Presented by H. Schmickler

In spring 2003 first contacts were made between American labs and CERN in order to define a potential framework for an American R&D program, which is aimed at supporting technological or scientific fields of the LHC accelerator.

In these discussions it was clearly stated that during such an R&D program certain equipment would be developed in the US by American staff, which later as fixed installation or as test-prototype would have to be operated by people from CERN.

In such a situation it would be of great help, if the American equipment experts could be made responsible beyond design and construction of their devices, by creating the necessary tools for **remote diagnostics and operation of accelerator components**.

At that moment a work-package had been formulated to develop the necessary controls infrastructure (network security, role based access rights) within the LARP collaboration.

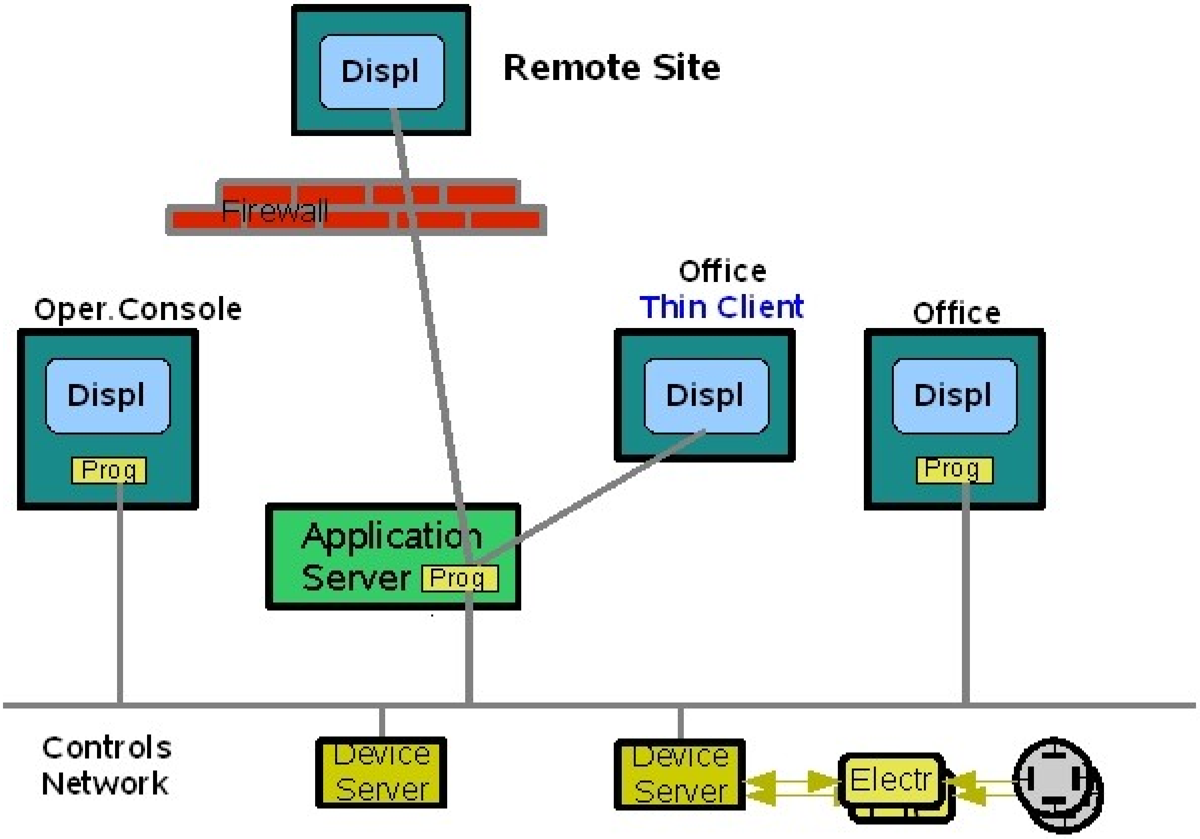
Due to later budget cuts this work-package was lowered in priority and is still awaiting funding.

GAN-MVL Overall Architecture

Kay Rehlich, DESY

As explained in the previous talks, GANMVL is planed as a toolset to support maintenance, measurements and trouble shooting from a remote site. Access to the control system, audio/video communication, integration of instruments for special measurements, access to documentation and optional high resolution video will be provided by the MVL. All parts are foreseen to be easily accessible from a Web page with the required user assistance. Granting access to the systems by login procedures for read-only or read-write permissions will be integrated as well as the usage of secure protocols.

Accelerator control systems are quite different in various institutes since their requirements and also their construction ages differ a lot. Therefore the integration of controls in the GANMVL should be independent of the site specific control system. On the other hand a remote expert should be able to see all and to control a lot of parameters. Because of the differences of control system interfaces and architectures of the institutes an adoption of multiple systems would take a considerable effort and is by far not within the scope of this project. Therefore, a transport of the images to a remote display of the numerous applications will be provided. This approach is called ‘thin client’ and has the advantage that no software upgrades nor library mismatches can be a problem since the actual software of the site to be controlled is used directly.

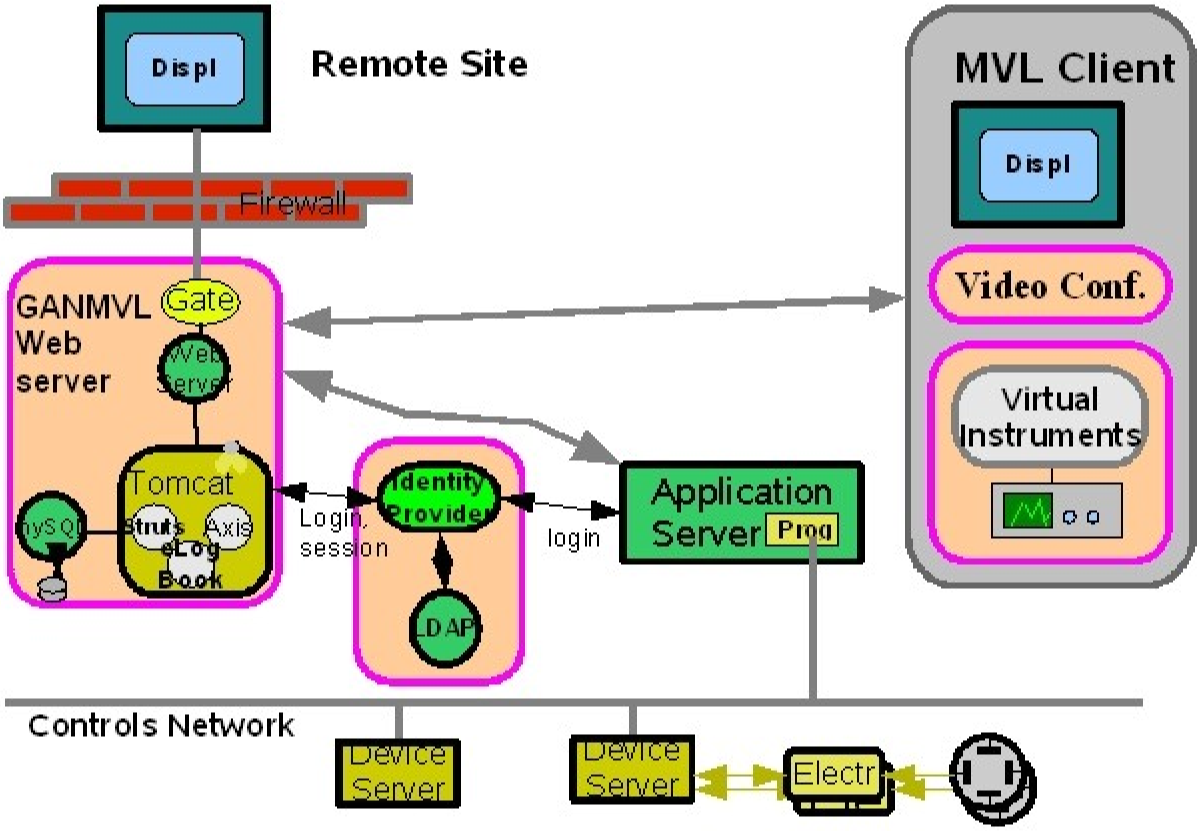


Integration of GANMVL into a control system. Yellow boxes with 'Prog' are the application programs of the control system

The main advantages of the thin client solution are:

- All applications run on a server at the accelerator site
- A remote user uses the same programs as the operators
- No special program development is required
- Minimal installation on clients required
- Platform independence can be achieved

Furthermore it is necessary to provide a common user friendly interface to all parts of the GANMVL. Web technologies are best suited since they are well known and accepted. But, opening a control system to the Internet requires an effective authentication system that protects from unwanted access but also let the local operators be aware of who is touching the machine. And the permissions to control certain points in the system should be restricted to privileged users only. All connections from the outside should be linked through a single or a very small number of connections of a firewall. With a firewall one can restrict the access to a limited amount of IP addresses as a further protection. The connection via the Internet should be 'tunnelled' by Secure Socket protocols. The linking of the tunnelled links to the different applications is the task of a gateway in the GANMVL application server.
In addition to access the data of the control system it is required for a remote user to be well informed about the activities of the whole facility. This could be achieved by integrating an electronic logbook into the GANMVL or, for sites with an own logbook, to provide the access to this. E-Logbooks are used by the operators to protocol all activities, e.g. Measurements and bug reports, of the facility and to give hints to others and in some installations to supply the documentation also.



Architecture with GANMVL Web- and application server and a mobile MVL client

Several options to transport images or screens from the server to the remote client are freely available. Mainly X11 and VNC are the solutions to be provided. VNC is available as an independent application and as a JAVA client also that can be integrated into a Web browser. This would allow fitting the control system interface into the Web frame work. On the client only a Web browser has to be available. The JAVA applet is automatically installed from a server.

Existing Industrial Solutions and Virtual Instrumentation Integration into GAN-MVL

Reinhard Bacher, Michael Seebach
DESY

List of contents

- Introduction
- Existing industrial solutions
- IVI-based instrument integration
- Steps to integrate a T&M instrument

Introduction

Stand-alone, off-the shelf T&M (Test and Measurement) instruments such as oscilloscopes, spectrum analyzers, signal and function generators or digital multi-meters are common, flexible tools to support experiments and trouble-shouting or diagnosis work in a mobile environment. Sometimes these tasks have to be done on short notice or only for a short time with limited preparation effort.

MVL (Multipurpose Virtual Laboratory) is designed to support such activities. Instrument integration is an important feature of MVL. With respect to instrument integration, visualization and / or control of T&M-specific functions through the MVL framework from a remote site is mandatory. The integration of the T&M-specific data flow into the MVL framework is a desirable add-on. However, the second objective is much harder to achieve.

Off-the shelf T&M instruments are highly specialized, stand-alone devices. Besides proprietary solutions, Windows is widely used as operating system. The embedded version is less vulnerable with respect to cyber threads such as virus attacks as the desktop-type Windows version. The distribution of viruses through the network becomes more and more a problem because in some cases security patches of the operating system of the instrument cannot be implemented in order not to decrease the T&M performance of the device or not to loose potential warranty claims.

Existing industrial solutions

The different vendors of T&M equipment have various methods to provide user access or to control the instruments. Examples are:

- Vendor-specific application software, which can be controlled remotely via a Windows Remote Desktop or VNC server-to-client connection. This very general method has the disadvantage to provide graphics, keyboard and mouse sharing, only.
- Alternatively, an internal web-server provides visualization and control pages. The quality of the graphics of those pages is often very limited.
- Sometimes, vendor-specific server software can only be accessed from vendor-specific client software through a vendor-specific network communication protocol. In general, those solutions are powerful, but expansive and not license free.
- Commonly used are user-customized instrument applications for instrument control, data visualization and data integration. Typically, a LabView virtual instrument (VI) interfaces to a vendor-specific instrument driver. So-called “Web-publishing” of the VI provides the remote user with a powerful application.

For MVL, three methods to integrate T&M instruments are proposed:

- VNC server-to-client connections,
- Web server-based instrument pages,
- Generic instrument applications (LabView VIs) using interfaces to IVI-compliant instrument classes.

IVI-based instrument integration

Industry has recognized the need of standardization because the compatibility of the different vendor-specific instrument drivers or virtual instrument software products is limited. Standards are proposed at two different levels:

- The VISA foundation (Virtual Instrument Software Architecture) has defined a standard for communication via different data buses.
- The IVI foundation (Interchangeable Virtual Instrument) has defined a standard for vendor-independent instrument access.

Besides many others, members of the IVI foundation are:

- Agilent Technologies
- Keithley Instruments
- National Instruments
- Rohde & Schwarz
- Tektronix
- LeCroy

The foundation has specified 8 different, generic instrument classes:

- DC power supply
- Digital multi-meter
- Function & Arbitrary generator
- Oscilloscope
- Power meter
- RF signal generator
- Spectrum analyzer
- Switch

The vendors of instruments provide IVI class-compliant, specific instrument drivers for their specific T&M equipment. The same VI application can connect without any modifications to instruments of the same type, but delivered by different vendors through the common, generic IVI API (figure 1).

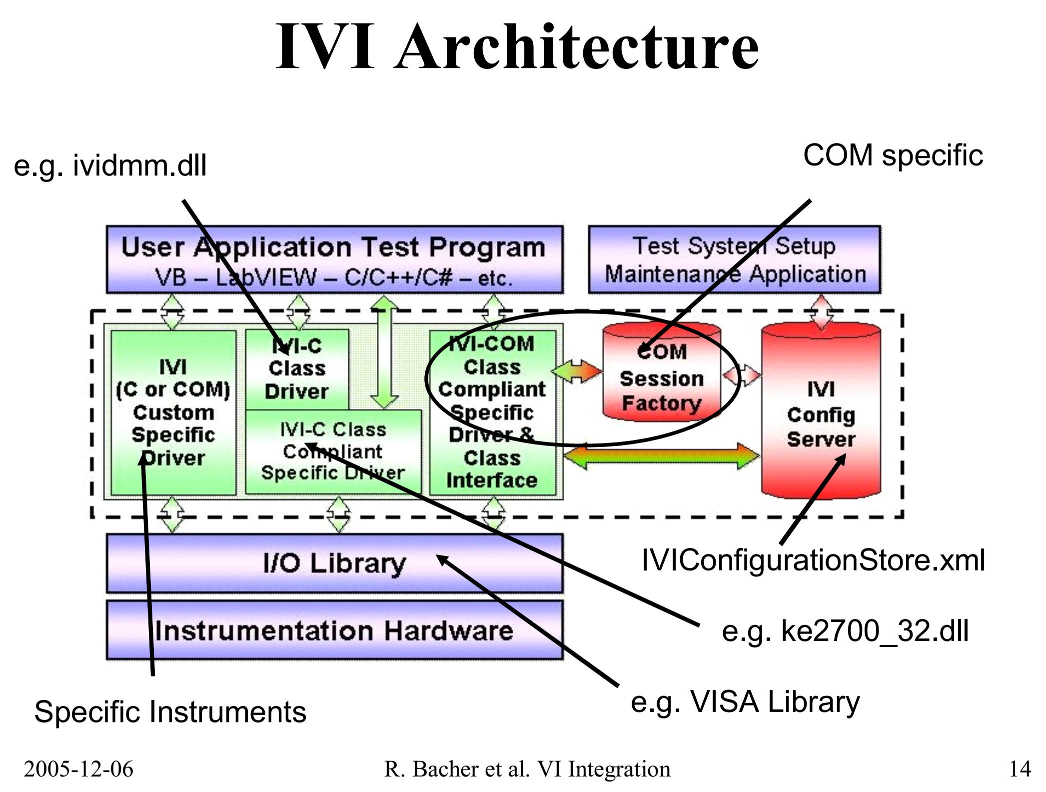
Each instrument type has its specific class library. The library consists of base methods and base attributes and so-called extensions (methods, attributes). The base classes are common to all instruments of the same type. The extensions can be instrument or vendor specific.

All instrument- and IVI-specific configuration parameters are stored in a configuration file. Individual logical names are assigned to the configuration parameters of different devices. Within an application, a specific instrument is identified by its logical name, only.

Two flavours of IVI classes are supported:

- IVI-C
- IVI-COM.

IVI-COM has a different, COM-compliant session management and provides native interfaces to all Microsoft-supported programming languages. IVI-C is preferably used in LabView VIs.



IVI Architecture

2005-12-06 R. Bacher et al. VI Integration 14

Figure 1: IVI architecture

Steps to integrate a T&M instrument

Prerequisites

- Install “IVI Shared Components” and “IVI –supported Instruments” class libraries (→ IVI foundation)
- Install “NI IVI Compliance Package” (→ National Instruments)
- Install “VISA Runtime” and “NI Measurement and Automation Explorer (MAX)” (→ National Instruments)

Integration steps

- Connect instrument to data bus and configure communication parameters, e.g. IP address
- Install IVI class compliant specific driver (→ instrument vendor or National Instruments)
- Configure the device interface parameters using MAX:
    - e.g. Specify / check IP address and TCP-port number
- Configure IVI Driver:
    - Specify / check hardware asset
    - Specify / check instrument driver software module

- Create driver session
    - Hardware
    - Software
- Create logical name
- Save IVI configuration into IVIConfigurationStore.xml.

Instead of using the NI Measurement and Automation Explorer, the IVI database can also be configured via method calls. In addition, the device parameters stored in the device configuration can be used to determine the corresponding IVI flavour. This information is needed to initialize properly the corresponding session handling.

CNIC at CERN

Computing and Network Infrastructure for Controls

P. Charrue – CERN AB/CO/IN

The CNIC Working Group

- Created by the **CERN Executive Board**
- Delegated by the **CERN Controls Board**

"…with a mandate to propose and enforce that the computing and network support provided for *controls applications* is appropriate" to cope with security issues.

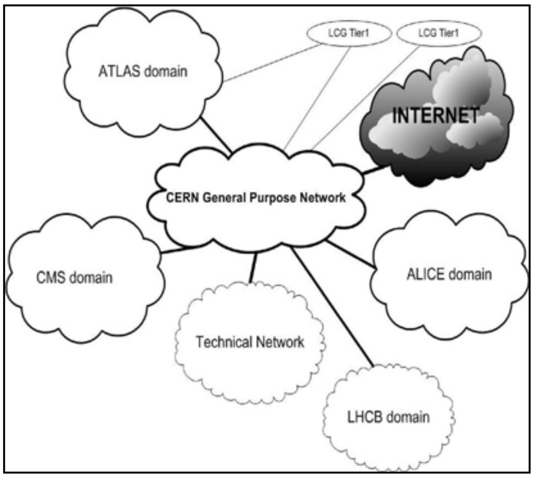
- **Members from all CERN controls domains and activities**
    - Service providers (Network, NICE, Linux, Computer Security)
    - Service users (AB, AT, LHC Experiments, SC, TS)

CNIC Mandate

- Define tools for system maintenance ("**NICEFC**" and "**LINUXFC**").
- Define tools for setting up and maintaining different **Controls Network domains**.
- Designate **person** to have overall technical **responsibility**.
- **Rules, policies and authorization** procedure for what can be connected to a domain.
- Ground rules, policies and mechanisms for **inter-domain communications** and communications between controls domains and the Campus Network.
- **Investigate** technical means and **propose implementation** plan.
- Stimulate general **security awareness**.

Networking

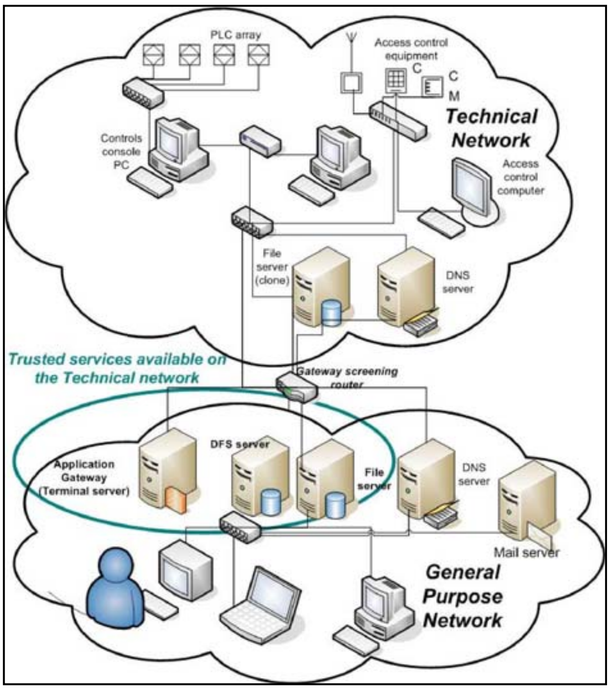
- General Purpose Network (GPN)
    - For office, mail, www, development, …
    - No formal connection restrictions by CNIC
- Technical Network (TN) and Experiment Network (EN)
    - For operational equipment
    - Formal connection and access restrictions
    - Limited services available (e.g. no mail server, no external web browsing)
    - Authorization based on MAC addresses



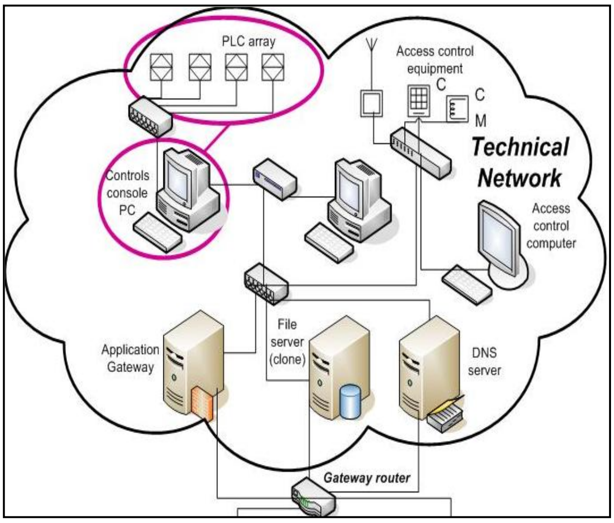
    - Network monitored by IT/CS

Use Cases

Office Connection to Control System:
Connection to application gateway
Open session to application (e.g. PVSS) with connection to controls machine and/or PLCs



Sensitive Equipment :
Vulnerable devices (e.g. PLCs) must be protected against security risks from the network
Grouped into Functional Sub-Domains
Access only possible from the host system that controls them
External access to the host system via application gateway



What one has to do ?

- **As hierarchical supervisor**
    - Make security a working objective
    - Include as formal objectives of relevant people

  - Ensure follow up of awareness training

- **As technical responsible**
  - Assume accountability in your domain
  - Delegate implementation to system responsible

- **As budget responsible**
  - Collect requirements for security cost
  - Assure funding for security improvements

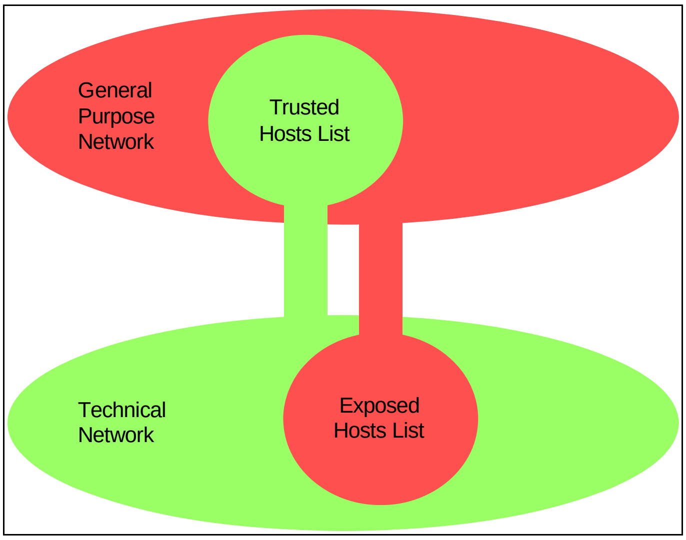
Proposed solutions

- Monitoring of the GN<->TN traffic
- Window Terminal Service (WTS)
- NICEFC and LINUXFC
- NETOPS forms to manage groups
- CNIC Users Exchange Forum
- TN connection authorization
- MAC address authentication

AB CNIC Strategy

- Deploy and maintain NICEFC and WTS
- All front-ends on the GPN will be TRUSTED
  - *See demo later*
- Important services offered from the TN and used by AB will be EXPOSED
  - E.g. all the databases for "Controls Configuration", "Settings", "Measurements" and "Logging", web server, PVSS application servers.
- Your development computers will be TRUSTED to start with. But only for limited time!

Graphical View



UseCase #1 : LINUX developer

- The LINUX development PC will be in the TRUSTED list
- It will have visibility of
  - the /ps files from ABSRV1
  - the configuration database
  - the IT CVS infrastructure
- The developer will be able to remote-login to a Front-End to deploy and test the new application
- In a second phase, a TRUSTED Application Server running LINUX will be made available for FESA developments. This Application Server will have access to all the resources (/ps, config DB, test or operational FE).
  - The LINUX dev PC will be removed from the TRUSTED list

Conclusion

- The CNIC is in the deployment phase now and January, 9th 2006 will be a very important step
- Almost every user has now been contacted and the CNIC Exchange User Group will allow for information flow
- The tools and solutions proposed by CNIC are available now and are deployed on the AB controls infrastructure
- We will start with long lists of TRUSTED and EXPOSED hosts. These lists will have to be shortened afterwards.
- We do not anticipate major problems for CNIC deployment and the CNIC experts will be fully available in January

References

All CNIC info

- CNIC WIKI pages

https://uimon.cern.ch/twiki/bin/viewauth/CNIC/WebHome

GAN: remote operation of accelerator diagnosis systems (with emphasis on hardware devices)

M.Werner, *DESY, Hamburg, Germany*

ABSTRACT

Driven by international collaborations, accelerator control hardware is installed in places where the expert himself is not present. The challenge is to operate this hardware reliably. The expert must be replaced by communication methods, and the hardware itself must be prepared to enable commissioning and service without the expert on the spot. This paper explains some topics for this kind of operation.

GAN CHALLENGES FOR HARDWARE REMOTE SERVICE

For commissioning and troubleshooting, a hardware expert normally has to be directly in the place where his component is located. This is necessary because he has to …

- reboot the system, monitor error messages during the reboot process while remote access is not yet running
- change software, CPU settings (e.g. IP address) and FPGA configurations
- change jumper settings
- calibrate offsets or amplification factors
- do oscilloscope measurements: at inputs and outputs, sometimes at internal test points
- check temperature and operating voltages
- replace hardware components
- analyze electromagnetic interference from / to other devices
- Look, feel and listen: correct cable type? Correct cabling? Fan running? Dust? Vibrations? LEDs on front panel flickering or displaying a certain state?
- These actions, however, are not possible if the expert is not on the spot. So the hardware must be prepared to permit most of these actions by remote access or make them dispensable.

HARDWARE COMPONENTS

If the device needs trimming or configuration, this should be possible remotely:

- Use remote controllable elements for trimming (avoid mechanical potentiometers)
- Replace jumpers by electronic switches
- Implement selftest if possible

REMOTE SOFTWARE AND FPGA CONFIGURATION UPGRADES

Software and FPGA changes need local access for many devices, e.g. by a local programming or configuration connector. This can be done by local staff in many cases. But a remote possibility for programming and/or configuration is preferable. But in this case, accessibility is an important topic. If the expert accidentally changes the kernel functionality, it can easily happen that he loses access to the system, e.g. if he introduces a bug into the signal chain which gives him the remote access. One way out is to ask the local staff for help. But there are other ways to avoid this:

- Clear separation between functionality for the remote communication and programming and configuration (not remotely alterable) on one hand and user functionality (remotely alterable) on the other hand
- Mechanism to fall back to accessible state in case of trouble: if the system is rebooted after a change and it is not validated as „good“ by the specialist during a certain time, it should fall back automatically to a defined software state to guarantee accessibility – see comparable Microsoft feature after changing the computer display resolution
- Other methods to guarantee accessibility?

REMOTE: CPU RESET, POWER ON / OFF, SERIAL MONITOR

- Extra web server which is able to reset the CPU and hardware and/or to switch the crate power on and off
- This web server should provide a serial connection to monitor the CPU startup process before the CPU can communicate over the network – only applicable to CPUs with serial monitor interface.

INTERNAL AND EXTERNAL STATUS

Implement remote check of:

- Temperature
- For special cases: noise, vibrations (use microphone)
- Supply voltage (absolute value, ripple)
- Supply current
- Presence and structure of input signals
- External clock (frequency?)
- External triggers (rep. Rate?)

Important internal signals:

- Internal clock running
- Others, depending on system

INTERNAL DATA LOGGING

- Log commands from and data to the control system including timestamps
- Log all(?) input and output signals (analogue and digital)
- If possible, log backplane and bus signals (VME, CAN)
- If possible, use an extra analyzer FPGA (with enough memory) for analysis and combination of inputs, outputs, commands, data
- Memory contents must not be erased by reboot!

POST MORTEM RECORDER

- If applicable, implement a circular buffer recording relevant data which is stopped when beam is lost to allow diagnosis about beamloss reasons.

OSCILLOSCOPE INTERFACE

- If the device deals with fast signals, implement a dedicated oscilloscope interface (with trigger and reference signals and monitor outputs) for remote analysis under unknown conditions, operated by a non-expert.

NEED FOR A CONTACT PERSON

Contact person has to

- Speak a language known to the developer
- Know the system roughly
- Be interested that the system is operational
- Normally be near the place where the system is located
- Have enough time to service the system if necessary
- Be able to operate tools like oscilloscopes needed for service

HUMAN COMMUNICATION

- Video conference?
- Video communication for 2 persons?
- Special document exchange (2 persons writing on a common drawing area on the computer screen?)
- Phone calls?
- Photos of the environment?
- Short videos?

BNL Experience with Remote Diagnostics

Peter Cameron , BNL

Outline

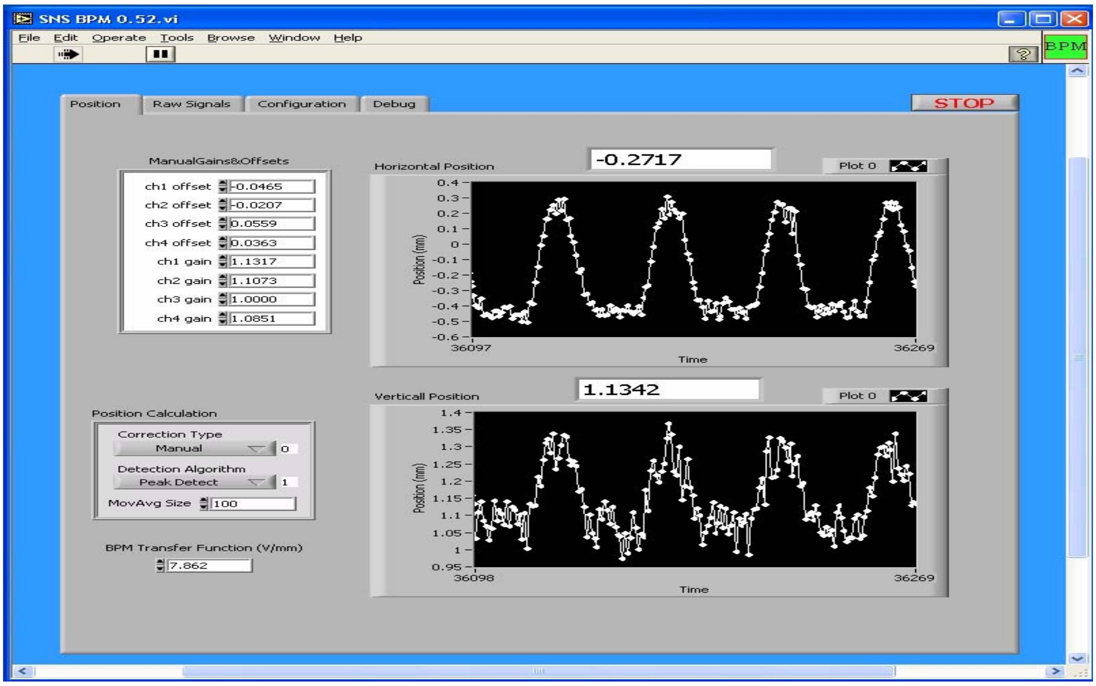
- Diagnostics for SNS
  - LEBT commissioning at Berkeley
  - Linac and Ring Commissioning at Oak Ridge
- Diagnostics for RHIC
  - Head-tail monitor
  - Tune (Artus and PLL), Schottky, WCM, BPMs,…
  - Electron Cooling
- Diagnostics for LARP
  - SPS - 245MHz PLL in 2004, BBQ in 2006
  - RHIC - 245MHz PLL, 3D AFE, BBQ,…
  - Schottky, Lumi, ???
- Scope and Problems

SNS – LEBT Commissioning at Berkeley

- BNL provided
  - 5 carbon wire scanners
  - 2 current monitors (Bergoz FCT)
  - 2 laser wire scanners - BCM readout
- System specialists were present at Berkeley for system commissioning and operation (a few weeks)
- Remote readout was available at Oak Ridge
- Problems of remote diagnostics not really present in this circumstance – system specialists on site

Communication Related Requirements

- Data Acquisition / Timing / Control by FPGA
    - Read ADC’s, buffer in local SSRAM
    - Read data out via PCI bus to PC memory
    - LabVIEW and EPICS access this shared memory
    - Select trigger input, RTDL – Front Panel – Soft
    - Select acquisition events when in RTDL mode
    - Programmable Gain (Both BCM and BPM)
    - Interface to Calibrator Board (BCM) or on Board calibrator setup (BPM)
    - Interface to RF Synthesizer (BPM)
- Communications to the PC are through the network – the PC communicates to the Front End through the PCI BUS.
- During initial testing at Berkeley the network was quickly overwhelmed.



ch1 offset -0.0465
ch2 offset -0.0207
ch3 offset 0.0559
ch4 offset 0.0363
ch1 gain 1.1317
ch2 gain 1.1073
ch3 gain 1.0000
ch4 gain 1.0851

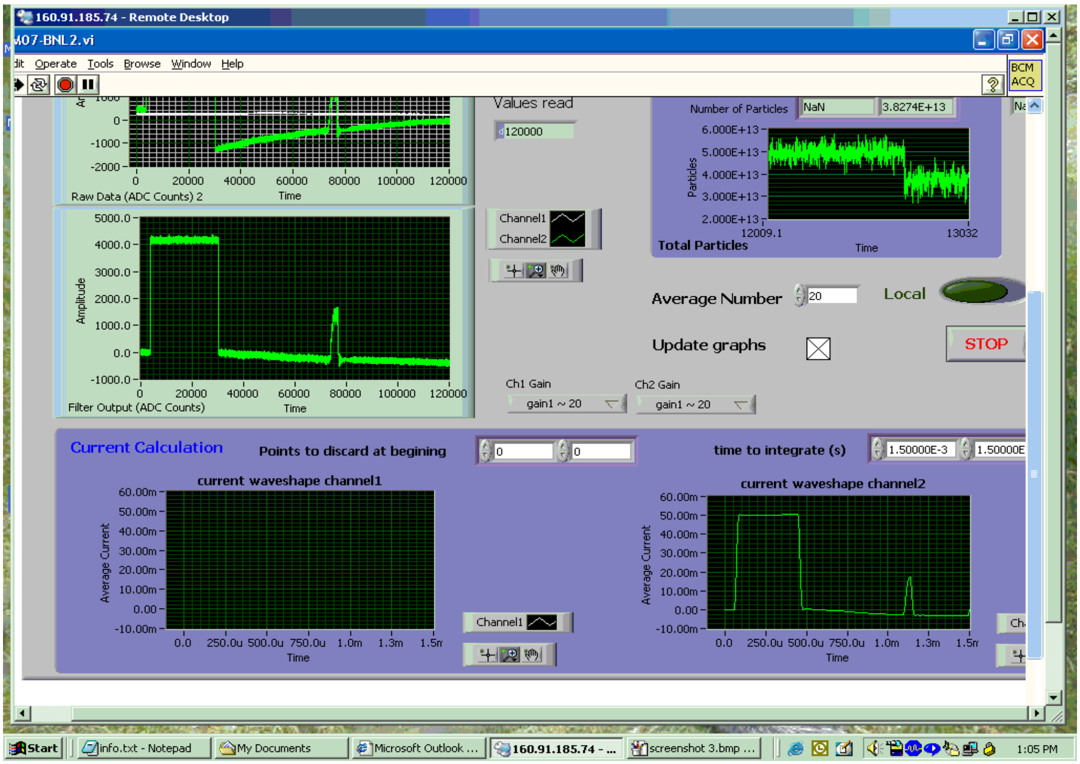
Horizontal Position -0.2717

Verticall Position 1.1342

Correction Type Manual 0
Detection Algorithm Peak Detect 1
MovAvg Size 100

BPM Transfer Function (V/mm) 7.862

Fig. 1: Position oscillation noted at BNL during commissioning of SNS. This information was given to the SNS Diagnostics group and traced to RF cavity cooling water problems



Values read 120000

Number of Particles NaN 3.8274E+13

Average Number 20

Update graphs ☒

Ch1 Gain gain1 ~ 20

Ch2 Gain gain1 ~ 20

Points to discard at begining 0 0

time to integrate (s) 1.50000E-3 1.50000E

Fig. 2: BCM during commissioning observed (using Remote Desktop at BNL) to display beam signal, but calibration pulse missing. Restored by repairing a connector with a bent pin (airline ticket!!!)

- In order to establish communications with BNL's equipment at Oak Ridge a VPN account was established by a BNL employee.
- This required the BNL employee to obtain an ORNL employee number and on-site security training.
- When attempting to connect to the equipment through VPN failed it was determined that the Firewalls at both locations were to blame.
- Exceptions for the IP's involved were finally (days later) enabled and communications with Remote Desktop were immediately established.

Head-Tail monitor (Chromaticity measurement)

- Implemented at RHIC in LabVIEW parasitic to kicked tune system, operated remotely from CERN
- Results
  - Remote Diagnostic operation was successful, required significant email and phone communication
  - Process was a bit slow, but because the work was of a development nature this was not perceived as a problem
  - Data quality seemed to be limited by quality of impedance match in the pickup
  - Manpower was not available at BNL to properly support the effort, to solve non-RD problems and make this an operational diagnostic
  - Would be a useful diagnostic in RHIC, hope to get back to it when priorities and manpower permit

Simple Access for Remote Diagnostics

- Full Access to all functionality of Control System
  - Security??? Significant trust here (Nuria, Rhodri,…)
- Bandwidth (cable modem) limits usefulness
  - Possible to improve displays with same BW?
- Other than BW, a very satisfactory solution

RHIC Tune, Schottky, WCM, BPMs,…

- System specialists routinely run and troubleshoot diagnostics systems from home
- In addition to GUIs, LabVIEW,… often requires ability to reboot VME, load DSP code,…
- Saves many late night trips into the lab
- Limitation is bandwidth, slow response of displays,…
  - This shows up most often during beam experiments, when there are frequent and significant reconfigurations of instrumentation for specialized measurements
  - similar conditions that might be found during commissioning (LHC, for instance)

Tune, Schottky, WCM,…

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Electron Cooling

- ‘high energy’ cooling becoming operational at FNAL
- Beneficial to RHIC eCooling efforts
- Desire to have access to raw data
  - Example – anomalous emittance blowup with beams centered
- No immediate plans to implement RD with FNAL, but worth thinking about (LARP overlap?)
- Manpower!!

LARP tune feedback

- BNL supplied PLL DAQ running in vXworks for SPS testing
  - ~1.5 man-months of BNL presence at CERN for this effort
  - Eventually the system was made to work
  - Effort became half-hearted with development of 3D AFE
- CERN supplied 3D AFE for RHIC baseband PLL
  - Beam studies at RHIC with commercial lockin system
  - Operation of VME based system
  - ~3 man-month of CERN presence at BNL for this and related efforts
- SPS run in June – BNL to supply DAB-based PLL
- Perhaps most important aspect of these efforts is ‘team-building’ for eventual LHC commissioning

LARP overall

- Presently 3 Diagnostics systems
  - Tune feedback – BNL, with some FNAL participation
  - Schottky – FNAL, with some BNL participation
  - Lumi – Berkeley, with some BNL participation
- Present plan is
  - DAQ for all 3 systems will be DAB-based
  - ‘identical’ VME crates will be delivered to all 3 labs, running LynxOS and with DAB boards
  - Goal is (to the extent practical/effective) to maximize commonality and share resources between the 3 labs
- Much uncertainty and many questions

Scope and Problems

- Scope (LARP perspective)
  - Much less than what is needed for GAN
  - Need definition of minimum requirements/permissions for LARP

        - Will also define (to some extent) effectiveness of LARP remote diagnostics effort
    - Need clarification of architecture, software,… that will be utilized to meet these requirements
- Problems
    - Learning curve for LHC control system – need effective plan soon to be ready for commissioning
    - Bandwidth???
    - Else???

Definition of work packages from the diagnostics view point

Summary of the discussion by A. Peters (GSI)

A. Remote maintenance of diagnostic equipment

Stimulating questions:

Are there any items not yet mentioned?
What tools would help you personally in your daily work, if it would exist?
What limitations would you accept and/or expect?
What is most important for you?

Synchronicity

- make sure that what you see is what I see
- Reliable Synchronicity
- Sync whit local op crew
- Diagnostic – Remote operation should respond of fast as the local system

Security limits

- Machine Operation – Secure access to controls network
- User limits (how many are allowed)
- Controls with remote access in mind (authorization, rules, …)
- Shared ownership responsibility → clear boundaries
- Try to avoid "Big brother is watching you"
- Operation – I would expect clear limitations on computer/ network access due to more restricted remote security

Usage

- Same diagtool or specific for remote?
- Same tools available anywhere
- Enhanced GUI
- Really difficult: Save + comfortable

Remote Development

- Bringing diagnostics beyond specification (also hold for other devices)

Controls

- Diagnostics – complete control system available by remote connection
- Access to Devices by 1 Standard Channel
- Remote DG already in Modern Controls
- Remote access: maximal use of diagnostics to improve operation

Communication tools

- acceptable missing video, not acceptable: bad audio
- R D - Establish common technical vocabulary (and) common diag tools
- Tools R D – Webex (Webconfercing tools) locks very promising

Miscellaneous

- R.M.O. – Launch prototype work on pattern recognition and comparison with reference diagrams
- diags 1) trust 2) bandwidth 3) establish presence 4) NAD Approach? 5) Timing interface 6) Adequate funding for handoff 7) Remote places normal instrument commissioning problems in foreground 8) Manpower at host lab is problem during commissioning 9) security 10) Software incompatibilities: LynxOS vs. VxWorks 11) R.D. steps for GAN 12) Learning curve for other control systems

B. Remote maintenance of diagnostic equipment

Alarming

- Push or Pull of maintenance info?
- Diagnostic equipment – Remote control /diagnostics of crates, power supplies, fans, etc.
- Recording of parameters creating alarms
- Maintenance- important: very good (complete) self diagnostic of instrument → Alarm to control system

"Product handling": Expert vs. normal staff

- Simple GUIs
- Simple & stupid
- Easy to use
- Maintenance: Access of instrument from Office/Lab

Design & development process

- Remote development with all mentioned tools
- Starts with development
- Small projects first
- Common diag interface?
- Diagnostic equipment – more/better interface standards between diagnostics and control systems and less variety
- Remote diagnostics of equipment – define prototype development (…) in order to quantify the effort
- R.M. equipment – Controversy: equipment fault ←→changing interface signals (timing references): Design systems self triggered
- Set up a checklist which remote functions are mandatory (for devices of a project)?
- Exchange of building blocks: FPGA config + hardware for e.g. oscilloscope function etc.
- Maintenance – each electronic (instrument) should have its own ID
- Extra effort into remote maintenance or into improved reliability?
- Diagnostic equipment – module identification, self tests, Init/Reset procedure built in

Team / Psychology / Motivation / Social Events

- Expert ←→ Robot

- Operation / Most important: willingness to record and summarize meetings that occur at odd hours due to requirements
- Sync with local equipment group
- Remote experts not physically close to CR → change OP habits
- Self diagnostics and new (digital) technologies: Level of training of staff?
- Most important: local op is aware of all remote actions
- Issues: involvement of operations limited
- Tools: Same tool for all
- Remote access needs local experts
- Need of certain minimum expertise at host lab
- Absolute transparency (no hidden activity)
- Make personal contacts per video conference: does this work?
- How to make management understand to work on collaboration instead of our "normal" work?
- Reparation of devices can only be done by expert locally
- Social aspects: Be pragmatic!
- Maintenance Tools: Network configurations built on greater trust between collaborating institutions
- Missing informal communication