Final Report of a Workshop

Enabling The Global Accelerator Network, GAN

Jointly sponsored by Brookhaven National Laboratory, Cornell University and Deutsches Elektronen Synchrotron, DESY

Mar. 21 - 23, 2002 at Cornell, Ithaca, NY

This is the first of two workshops under the same sponsorship. A second workshop emphasizing remote operation/control and possible prototype experiments will be held at Shelter Island, nearby Brookhaven National Laboratory, Sept. 17-20, 2002

Introduction

Driven by our need to know what we can about our world, we appreciate the necessity of a global approach to create a frontier facility. Building on existing cultures of collaborative science we hope, together, to reap a harvest of science, share and share alike from beginning to end. We think we see a way of accomplishing this via the GAN.

The workshop brought together an eclectic mix of experts from information technology, nuclear physics, particle physics and accelerator communities. Some of us are primarily interested in the remote operation aspects of the subject, others primarily in the social and collaborative aspects and many in the whole.

The agenda is to be found in Appendix I. In plenary session we were briefed on the current status of collaborative tools based on foundation web technologies and given live demonstrations of remote operations of a particle physics experiment, CLEO and of the Tesla Test Facility accelerator in Hamburg. While there remain challenges in remote operation technology itself there are now many tools for this. More challenging will be the socialogical aspects both of remote, collaborative operation and, even more so, of equal partner collaboration in creating the facility. It will be important to engage with these challenges at an early date since experience shows that many iterations will be required before arriving at the desired end.

In Working Group sessions we grappled with understanding these three areas:

WG1 - "Elements of a Global Control System",
WG2 - "Tools for Implementing Control Systems", and
WG3 - "Communication and Community Building".

Summary reports as presented in the closing session of the workshop are to be found below, edited to encompass suggestions made by participants during these summary presentations.

Working Group 1 -
Elements of a Global Control System

- Matthias Clausen (DESY)
- Paul Czarapata (FNAL)
- John Galambos (SNS)
- Richard Helms (S)(Cornell)
- Steve Herb (DESY)
- Tom Himel (SLAC)
- **Dave Rice (c-O) (Cornell)**
- Todd Satogata (BNL)
- Hamid Shoaee (SLAC)
- Nobu Toge (KEK)
- Karen White (JLAB)
- **Ferdinand Willeke (O) (DESY)**

Working Group Outline

- **Key questions for discussion**
- **Standardization vs. Integration** (w/ WG2)
- **Summary of ATF↔GAN** (Nobu Toge)
- **R.S. Larsen VGAN proposal** 2/13/02
- **Topics for GAN ~~demo~~ prototype project** (w/ WG3)

Key questions for discussion

- **1% problem**
- **Controls Architecture Considerations**
- **Better diagnostics** (covered in 1% problem)
- **Organization of maintenance and spares**
- **Operator training**

Topic 1 - the 1% Problem

The 1% problem:

Extrapolating from existing machines, on about 20-occasions/year experts presence on site may be required. For a GAN type of machine this would probably mean an interruption of operations of 2 days in each case when extended air travel is involved.

This is a potentially serious problem

1% Problem … possible remedies

- Improve internal diagnostics (beware introduction of more possible failures), extensive self checking
- Reliable engineering concepts
- Extensive logging
- Precise event time stamping and triggered high time resolution logging
- Using the local maintenance as the hands and the eye of the expert
- Every Problem investigated and documented
- More attention to remote diagnosis
- Complete function checklist, more formal handling of all actions (access control) There should be formal systems for example in industry
- Staff responsible for follow-up, error documentation, error statistic, reliability officer
- Environmental awareness monitors (noises, vibration, smell, humidity, environmental temperature) should be explored

1% Problem - Conclusion

- **None of the above looks outrageously expensive**
- **All would be desirable for a non-GAN (locally controlled) machine as well.**

Controls Architecture Considerations

- What are the main arguments for local versus distributed computing (thick versus thin client)
  - Data distribution issue w/ thick client
  - Thin client looks less problematic
  - must make case for thick client (3-d visualization)
- Do the remote control rooms really have to be identical
  - Yes - in function at least
  - Tools should be accessible from all primary c.r.
  - Language, naming uniformity critical
  - Standard crew composition requirement?

Controls Architecture Considerations

- Will comprehensive system simulation play a major role in software development, testing, trouble shooting maintenance and development?
  - Important to test middle- top-layer software before hardware is in place
  - System designers should provide simulators
  - Checks standards, builds community
- Is there a need for a global control system (uniform across accelerator)
  - Need a global architecture for complete system
  - Need well organized central controls group - uniform standards
  - Site lab must not become dominant - must have representation from all major partners

Organization of Maintenance & Spares

- **Are faulty components to be shipped back to source for repairs?**
  - Ownership and responsibility stays with the equipment provider - determines means of repair/maintenance
  - Offsite repair likely were feasible
  - However, should consider training/involvement of local staff
  - Centralized tracking system essential
- **Do we need an increased spares inventory?**
  - Not obvious - case-by-case evaluation required

Operator Training

- We need common operator training
- Simulation systems seem problematic - work needed
- Logging and playback of incidents potentially useful
- Mixing operator teams between labs useful

Standardization vs Accommodation

- **How far through system must uniformity of controls be required.**
  + Uniformity →lower cost, better maintainability, less confusion.
  - Accomodation →more flexibility for designers - can stick with well known systems, more feeling of ownership

Standardization vs. Accommodation

- **A standards committee should be formed at earliest possible time, with representatives from all major partners.**
  - Uniform standards where possible
  - Make groups aware of other groups' common efforts
  - Urge conformity - exceptions will happen
  - No rush to determine ALL standards immediately - technology is moving target
  - Long term project, need technical experts, R&D
  - 3 regions currently designing equipment - how to promote communication between them?
  - Language, software development, documents, testing, QA standards are all needed

Consideration of GAN for ATF (N. Toge)

- X Radiation safety reporting path to gov. critical - must have shift leader in on-site control room.
- ✓ Network bw, security seem ok
- X Most documentation in Japanese
- X Shift leaders' job changed psychologically
- X GAN as afterthought is bad idea

Decide not to pursue GAN for ATF

This project was done in 2000 and the conclusion was heavily influenced by the conclusion that the GAN concept was introduced too late in ATF development. Some conclusions:

- GAN needs very careful preparations and attentions to the details as an integral part of planning from a very early stage of the project, (otherwise, it won't work) and
- GAN cannot start from the "time-zero" of the initial commissioning, where a large fraction of the members must be on site anyways. People need to share the time of working together on the central site, then gradually we decentralize the operation mode as the system stabilizes. GAN is a system which is designed to make that transition smooth.

Virtual GAN

- **Extensive GAN simulation system proposed by R.S. Larsen**
  - Based on panels from existing machines
  - Fed simulated real-time data reflecting all phase of accelerator startup/operation/problems
  - Failures programmed into model
- **Group consensus was that project is ambitious.**
  - Needs significant funding, people, completeness of outcome is not clear
  - Simulations are most useful as operation is approached

Aspects to be considered in a prototype GAN project

Done already in remote mode? (no 0,1,2,3 all)

Priority for test? (low 0,1,2,3 high)

1 Control

1.1 Routine operation 1,3

1.2 Machine development 1,3

1.3 Abnormal conditions 0,3

1.4 Equipment commissioning 2,2

1.5 Subsystem calibration 2,3

2 Monitoring

2.1 Current overall status 3,-

2.2 subsystem, component status 3,-

2.3 archived data 3,-

3 Diagnosis

3.1 Fault localization 1,3

3.2 subsystem testing 2,3

3.3 Remote hands & eyes 1,2

4 Communication

4.1 Real time between on-site, off-site control room 1,3

4.2 Shift turnover 0,3

4.3 Group meetings 2,2

4.4 Social dynamics 1,3

4.5 Elog 1,2

5 Coordination

5.1 Remote access authorization 0,2

5.2 Accelerator program 0,2

5.3 Specialists intervention (3-sites) 0,3

5.4 Operations, experiments analysis 1,2

5.5 Maintenance 0,2

6 Security

6.1 Keep out hackers 2,1

6.2 Operation with normal security between labs 0,3

6.3 Access authorization 2,1

6.4 Access accounting 1,2

6.5 Protection of vital systems 2,2

6.6 Maintaining operation envelope 3,2

Other random comments

- Shelter Island Workshop
  - 45 person limit may preclude attendance by controls, operations experts -- 60-80 would be good size.
- Must let people know what GAN means - a clear, concise statement needed.
  - Let labs continue partnership role during commissioning, operation, maintenance, upgrades of facility
  - Allows remotely located control rooms
  - Minimize need for experts on all systems on-site
- Possible Proto-GAN sites are LINX (SLAC), Photo Injector 3 (FNAL), TTF (DESY)

Report from Working Group 2:

Tools for Implementing Control Systems

Summary

I. Organization of This Report
II. Definition of Working Group's Task
III. Conclusions
   A. There Are No Fundamental Technical Difficulties with Creating a GAN
   B. The Users' Needs Have a Strong Impact on the Choice of Tools
   C. We Need to Continue the Discussion Begun at This Workshop
   D. The Work of This Group Needs to Continue by Iterating Using the Conclusions from the Other Working Groups
   E. We Recommend Setting Up a Steering Body to Begin Addressing the Issues Associated with Standardization and Accommodation.
   F. The Collaborative Approach Tends Increase Accommodation by Broadening the Degree of Desirable Standardization

Appendices

I. Control Systems from Different Perspectives
II. Functional Perspective for a Control System
   A. General Model
   B. Hardware Projection
   C. Software Projection
   D. Human Interaction Projection
   E. Access Control Projection
   F. Addressing Areas of Special Demands Placed by GAN
III. The Control System Viewed from the Users Perspective
IV. The Control System Viewed by Modes of Operation
V. Useful Tools for a GAN Control System
VI. Standardization vs. Accommodation

Working Group 2 Members:

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Summary

I. Organization of This Report

This report is organized into two sections. The first contains the definition of the task set before Working Group 2 and the conclusions from its deliberations. The second section is a group of appendices which outline and define terminology for an example of a possible Global Accelerator Network (GAN) control system which was considered as a model for the discussions, give various perspectives from which this model may be viewed, describe the special demands that GAN would place on the accelerator's control system and present some thoughts on the standardization of controls and accommodation of different control structures and philosophies.

II. Definition of Working Group's Task

The task for working group 2 was to focus on the tools necessary to create controls capable of operating a linear collider (LC) as part of a global accelerator network (GAN.) The group outlined a control system (CS) model which was sufficiently general to be representative of number of possible configurations for a GAN CS, and yet was sufficiently specific to permit discussion of more concrete issues. Although the working group initially focused on the technical issues which might prevent or limit the implementation of a GAN as distinct from issues which are faced by large accelerator complexes on an extended sites, it became clear that most of the problems facing a CS for such an extensive single accelerator site were not much different from those faced by a GAN CS. As a result the group was able to extend its discussions to issues relevant to large accelerator complexes. In addition although some of the considerations are specific to a LC, most are unchanged, independent of the type of the acceleratorcomplex.

III. Conclusions

A. There Are No Fundamental Technical Difficulties with Creating a GAN

Beginning with a model of a control system for a particle accelerator, the working group considered issues which were unique to this control system functioning as GAN. Issues that were discussed included control system security between remote sites, passing control between control rooms and human communications between distantly separated control rooms, such as ways of presenting diagnostic information to distant experts. The consensus was that solutions for the GAN-specific issues facing a GAN control system exist today and that these place only slight additional constraints on the design requirements of the large accelerator's control system.

B. The Users' Needs Have a Strong Impact on the Choice of Tools

As is always the case with CS design, the attention of the designers must focus on the requirements of the users. For a large accelerator this is critical and for a GAN CS this is paramount. In a GAN CS one must add remote site users and intermediate level software control processes to the conventional list of users. Also human communications and the passage of executive control over large distances and multiple cultures must be included in the CS design.

C. We Need to Continue the Discussion Begun at This Workshop

This workshop was particularly useful for convening accelerator controls and operations experts from a large number of the world's accelerator laboratories and HEP detector controls to discuss the implementation of a GAN CS. Many useful ideas were presented, important not only for a GAN CS, but also for the design of a CS for a large accelerator facility. The work here is only a beginning; much more is to be completed before a GAN CS can be realized.

D. The Work of This Group Needs to Continue by Iterating Using the Conclusions from the Other Working Groups

Useful ideas and concerns were presented by the other working groups which will need to be incorporated in the deliberations of the next workshop.

E. We Recommend Setting Up a Steering Body to Begin Addressing the Issues Associated with Standardization and Accommodation.

Before a GAN CS design for a LC can be completed, a set of definitions of controls for elements and standard communication protocols must be established not only for the computer hardware and software interfaces, but also for the humans operating the accelerator. This working group recommends that an international steering committee be established for a real future GAN project with members from all interested accelerator laboratories and university groups. It may be anticipated that the task will evolve to be (re-)defining and preserving standards during the design, construction and running phase of an LC accelerator.

F. The Collaborative Approach Tends To Increase Accommodation by Broadening the Degree of Desirable Standardization

The accelerator community will benefit by involving experts from all interested accelerator laboratories and university groups in the process of developing standards for a GAN CS. The process will be more accommodating to the accelerator community at large if multiple specifications for controls and communications protocols are permitted at some or all levels within the control system. However, one has to fight for standards. Particular attention must be paid at each level to maintaining a balance in the tension between having one specification and many specifications.

Appendices

I. Control Systems from Different Perspectives

In this report the definition of a control system has been expanded from the more traditional definition of the hardware and software needed to adjust and monitor the elements of a particle accelerator. Due to the remote site control requirements, a more encompassing definition is needed. So a GAN CS is defined as the hardware and software needed to monitor and adjust the elements of a particle accelerator, to facilitate the secure communication of information and transfer of executive privileges between collaborators operating the accelerator over large distances.

A GAN CS will place added constraints on the designers. To assist the design and operation phases of the CS, it is important to consider all aspects of the CS's operation. Three different perspectives for a CS have been considered and are found to be useful for evaluating a GAN CS. These views are here called the Functional Perspective, the User's Perspective and the Operational Perspective. These will be considered carefully in Appendices II, III and IV. Useful tools for a GAN CS are presented in Appendix V. Lastly in Appendix VI some ideas are examined about standardization of controls and architecture while maintaining an ability for the control system to accommodate different architectures. The working group was aware of the fact that discussions on tools will be much more specific when a real GAN project with a well-defined technical and management framework has been established.

II. Functional Perspective for a Control System

The Function Perspective of a CS models the CS as a mechanism used for accomplishing the control tasks. In the case of a GAN, the organization of a CS may be projected onto four different levels of abstraction. The first two of these are the quite familiar hardware and software projections. The other pair of projections are generally found to some degree in present control system architecture's, but with a GAN their importance is underscored. These two projections are the Human Interaction Projection and the Access Control Projection and they deal, respectively, with the communication needs of the personnel operating the CS and their ability to access and command the information and control of the CS. The next sections will present a general model for a GAN CS from the Functional Perspective and will outline issues as viewed from the various projections.

A. General Model

In order to discuss the various projections of a GAN CS, a reasonable structural model is useful. One of many such general structures is shown in Figure 1. Different functions are encapsulated in different layers. The integrating core of the control system is a framework providing Interfaces and Protocols. Client APIs are provided to serve various clients in the GUI Layer. These clients can be located on site or off site, can run on different platforms and can be implemented as thin or thick clients. Similar, Device Server APIs serve the various Device Servers of the Resource Layer housing the basic server services. Gateways to complete sub-control systems could also be provided. Middle Layer Applications provide system wide services such as logging, alarming, automated tuning processes or composite devices etc. Although this is a specific middle layer application, in later discussions the Logging Functions will be singled out as one of the more resource intensive processes with which the central control system must contend. Since this structural model is intended to be fairly general, the more detailed descriptions of the various control structures will be found in subsequent sections of this report.

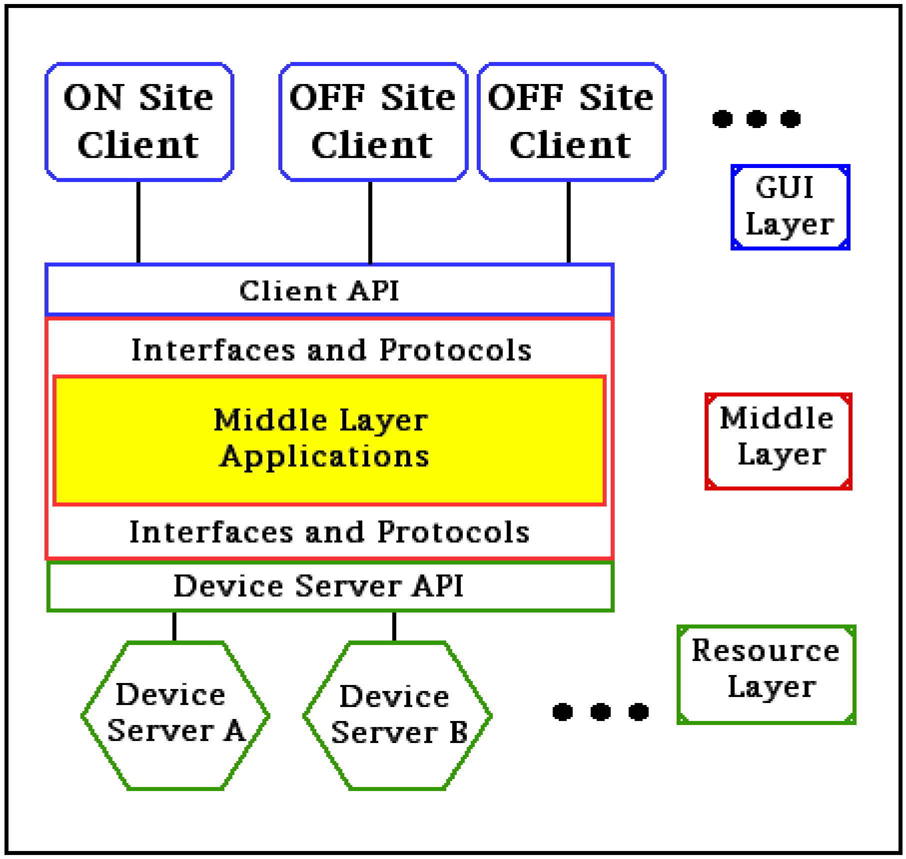

Figure 1. A very simplified general structure for a GAN control system.

B. Hardware Projection

For most control systems and, in particular, for the GAN CS structure, some parts of the CS may serve multiple roles in the block diagram of figure 1. One example of this may be found in the hardware implementation of a control room's console. For the console there may be a computer with window displays allowing operators to communicate via application programs. Simultaneously that same computer might house a portion of the remote device driver software, which communicates with device server hardware connected to knobs, joy sticks or track balls for the same control console.

Viewing a CS in the hardware projection provides information about the electronic equipment in use. A modular approach with well separated functions is a must. The GUI Layer consists of sets of computers and their displays located on site as well as off site, terminals and various mobile devices. Equipment specific for tuning such as knobs, joy sticks or track balls and the corresponding interfaces have to be provided. The Resource Layer will be probably dominated by distributed crate-like systems of various industrial standards with stand-alone or embedded CPUs. In addition, interfaces to front-end electronics and data bus or field bus hardware will be provided. The Middle Layer consists of sets of computers residing on site together with data storage equipment and Ethernet network hardware which is the overall connecting element.

C. Software Projection

The software projection of a CS includes all of the computer operating systems, low level process control code, intermediate and upper level application program code, the database structure, off-line analysis applications and management and scheduling applications for the accelerator and for passage of the executive privileges (determining which control room is in control) for the accelerator between Clients. The software at the Client Sites provides console controls and displays, off-line analysis capabilities for logged data and for measured accelerator parameters. The Client API and the Device Server API software provides programs which communicate between the Clients or the Device Servers and the central Interfaces and Protocols framework, respectively. In the Middle Layer Applications section, the software handles the upper level controls functions, e.g. starting or stopping injection, adjusting accelerator parameters, correcting orbits or trajectories, measuring accelerator parameters and logging data. The software at the resource layer provides software routines specific to read out and control the front-end electronics attached. The core framework Interfaces and Protocols handles the communication contracts, provides interfaces to various systems or standards as well as the necessary databases, name services, semaphores, time stamps etc. and gateways to sub-control systems.

D. Human Interaction Projection

The Human Interaction Projection of the GAN CS contains all of the short and long distance human communications. Between Clients at different sites this communications includes voice, teleconferencing, methods for sending on-line and off-line data and parameters, an electronic logbook, on-line documentation, and scheduling and other management, repair and maintenance information. At the software levels of the CS this projection would include the documentation, which is internal to the program code and the help manuals for the users. In the resource layer there would be an on-line description of systems, their interfaces, controls and operation.

E. Access Control Projection

The Access Control projection deals with the security issues of the GAN CS. For different Clients the access control issues deal with secure computer and CS communications, securely passing the executive control (full operating privileges for the accelerator) to the between Control Rooms and the degree that the On Site Client can override an Off Site Client's executive control. In the software sections this projection views the degree that users can view, create, modify or delete software, files and documentation. In the hardware sections Access Control would determine and enforce which operations to hardware are permitted by each Client, e.g. the right to power equipment during an access period for the accelerator.

F. Addressing Areas of Special Demands Placed by GAN

Although in very many respects the requirements for the CS of a large accelerator coincide with those of a GAN CS, the working group was able to identify several areas for which a GAN CS raises special needs. An organized list of these special requirements are found in table 1.

Control System	**Projection**			
Component	**Hardware**	**Software**	**Human Interaction**	**Access Control**
On Site Client		Tuning Applications	Executive Control	Security
Off Site Client		Tuning Applications	Executive Control	Security
Client API				
Interfaces and Protocols	Data Transfer Rate	Standardization		
Middle Layer Applications	Data Transfer Rate	Data Transfer Rate		Compartmentalization
Device Server API		Standardization		
Device Server	Standardization	Standardization		
Extracting Logged Data	Data Transfer Rate	Standardization	Analysis	

Table 1. Control system components cross referenced by projection with entries where GAN places special constraints on a Control System.

For the On and Off Site Clients there are three related areas which place constraints on the CS architecture. These areas center around establishing adequate security for all access to the CS. On one side the CS must have such elements as firewalls to make it very secure against unauthorized access, while on the other side maintaining a control data rate necessary for tuning. One possible configuration capable of maintaining secure communications in the presence of a high control data rate was discussed by the working group and is found diagrammed in figure 2. In this configuration the Off Site Clients are connected to the On Site Client backbone using a private leased line between the sites. Essentially this places the hardware for all Clients' control consoles within the same firewalled network.

The third area of special constraint for the Clients is found in the mechanism for handling the scheduling and passing of primary control between different control rooms. At any point in time the control room in control of the accelerator is said to be have the "executive privilege" for operating the accelerator. Methods will need to be developed for seamlessly and securely passing control from one control room to another.

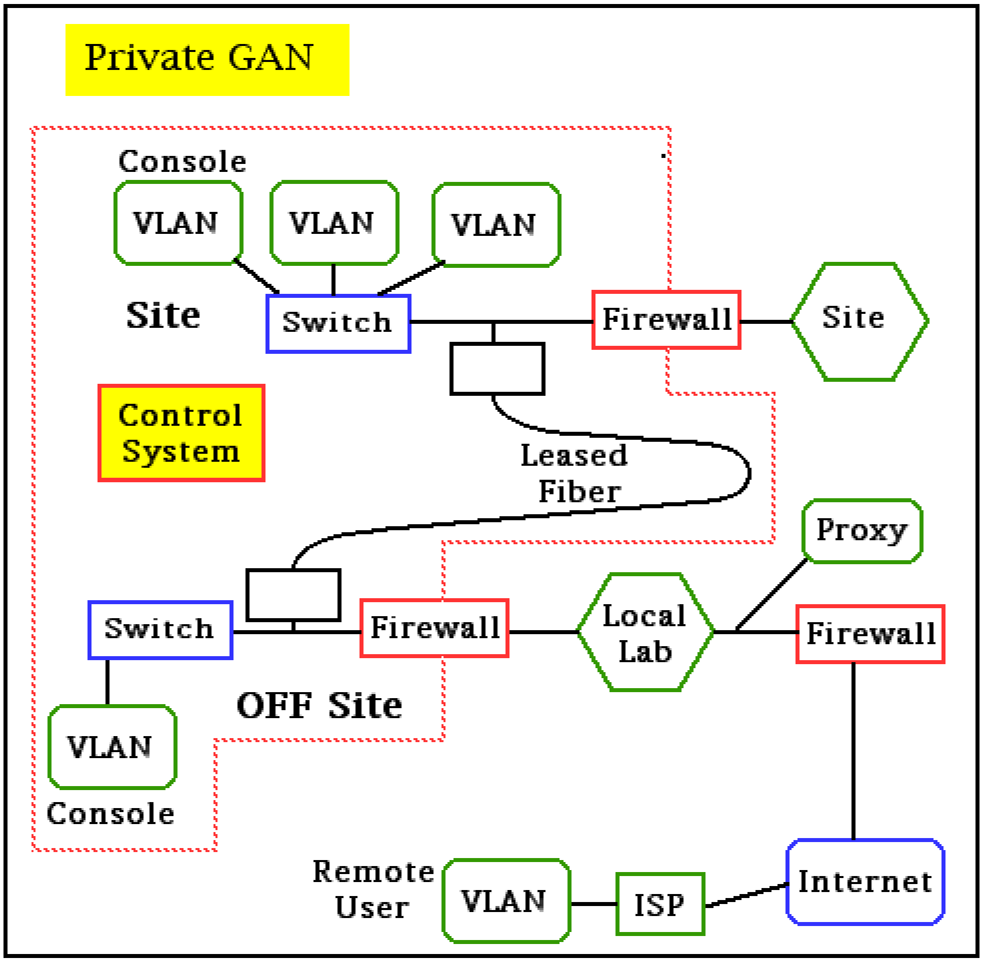

Figure 2. A possible method for interconnecting ON Site and OFF Site control rooms.

For the Interfaces and Protocols section of the CS, the data transfer rate may also be affected by the choice of the CS configuration employed to maintain adequate security. In this section, the addition of encryption (to allow operation over the conventional internet network) or unnecessarily complicated communication standards can greatly reduce the data transfer rate available for control. Clearly a set of communication standards must be established for the interconnection between this section and the Client API section, but care must be taken to maintain a high data throughput.

The Middle Layer Application section will contain a relatively large number of software modules, some of which will receive commands from the consoles of the Clients or from other Middle Layer application processes. Clearly the choice of the Middle Layer Application hardware and the degree of standardization of the interprocess communications will affect the response of the GAN CS. Also the degree to which the software modules may be compartmentalized will determine the long-term maintainability of the CS software.

For a GAN CS the Device Server API's and the Device Servers will need specifications for one (or more) standard set(s) of communications protocols and a set of definitions of the available parameters under control for each type of accelerator component. The difficulty here will be in maintaining adequate documentation which is understandable for all participants who are creating or using accelerator components which are interfaced to the CS.

The last row in table 1 identifies a particular Middle Layer Application for extracting logged accelerator data. This example was chosen to emphasize some of the GAN CS-specific design concerns will need to be addressed. In this case the there is an Off Site Client who wants to examine the data logged for some of the accelerator parameters over a several month period. Analysis tools will need to be developed in the Middle Layer Application section to be sure that the data being sent to a remote site is sufficiently compressed to avoid trying to send multi-gigabyte files over remote network lines and yet the compression must preserve the features of the data which are required, e.g. average value, rms value, peak values etc. vs. time. However, independent of the actual implementation of the tools a good performance of the tools is paramount.

III. The Control System Viewed from the Users Perspective and by Modes of Operation

In order to make a proper choice of the tools and a proper definition of the features of a GAN specific control system the needs of the users of a GAN control system must be carefully analyzed.

It turns out that GAN specific issues often overlap with issues specific to a control system of a large-scale accelerator. Examples are

- Supporting tools such as alarm generators, report and logging facilities, viewing tools for trends, history plots, correlations and statistics tools, documentation and help tools, wizards and templates
- Advanced automation capability, scripting and sequencing tools
- Interfaces to databases, office, scientific and other commercial software packages, field-busses and industrial standards
- Powerful GUIs and development frameworks

- Highly complex and problem-oriented as well as general and overview-oriented applications
- Problem-oriented control system APIs
- Access to all system parameters, etc.

Different user groups would require a GAN control system. Their needs are governed by their corresponding tasks ranging from technical commissioning, diagnosing and solving problems to operations and machine studies.

- Machine operations crews
- Machine coordinators
- Accelerator physicists
- The experimental groups
- Hardware / Software experts responsible for subsystems
- Application Programmers
- Software experts responsible for system integration and functionality
- IT system administrators
- Crews responsible for local maintenance of accelerator and utilities subsystems
- Automated "middle layer" processes

    A large-scale accelerator and in particular the collaborative worldwide GAN make automated background processes indispensable. These non human users have needs different from the needs of human users. In general, they are less patient and require a higher degree of standardization of the implemented tools (see below).

IV. The Control System Viewed by Modes of Operation

Although the working group only spent a brief amount of time considering this view of a GAN CS, a few remarks should be made. The view of a control system with respect to its modes of operation requires the CS designer consider all features of CS which are necessary for the accelerator to function effectively in all of its operational configurations. The typical list of modes of operation for the CS in roughly chronological order includes accelerator component testing, commissioning, diagnosing problems, routine operations and machine studies. Since it is possible to determine which features of the CS are required for each mode of operation, it is then possible to set priorities on the various tasks which create the entire CS and to schedule the order of completion of the tasks.

V. Useful Tools for a GAN Control System

The discussion of the working group focused on tools and features specific to a control system following the GAN approach.

- It turned out that a tool is required to handle the various user access rights and to make the actual status of controls privileges (executive privileges) transparent to hand over to different users (e.g. for actual repair purposes). An option has to be implemented to reset all ad-hoc privileges by the control room in charge.
- Training and documentation is a multicultural task. A tool should be considered allowing a unified training for operations and maintenance personnel. The implementation of a simulator tool could simplify the training task. The usage of a "common" language is recommended.
- Experience from existing accelerators (e.g. SLAC) show that real-time knobbing and scripting for accelerator tuning has to be supplied. A 10-Hz response should be sufficient to provide a fast and reliable response. The tuning tool has to reside on-site. It is recommended to replace real-time tuning by automated processes as completely as possible. In general, a careful usage of real-time applications is recommended because real-time server processes have to be properly shielded from processes which are not time critical.
- Automated "middle layer" processes have to rely on a control system consisting of distributed objects and their properties and methods. In particular, a common alarm, error, exception and event handle scheme is required. The "middle layer" processes may interconnect very different low-level processes at various platforms. To ensure a long-term perspective in the rapidly changing software market a platform-independent implementation of "middle layer" processes is highly recommended.
- The control system must be prepared to run over 25 or more years. A great challenge will be to manage the unavoidable changes of software and hardware standards. A modular system approach will be helpful.
- Application programms should be supplied in a platform-independent implementation, being aware that the available features and the over-all performance will be different on a thick (e.g. workstation), a thin (e.g. X-terminal) or a very thin (e.g. hand-held device) client. Implementations based on Web technologies are promising. Tools have to be provided to maintain software updates and to keep the software libraries consistent.
- In general, an on-line accelerator simulation or modeling tool could provide great benefit for experts responsible for subsystems as well as application programmers. It should run at the site of the accelerator.
- It is proposed that experts will provide troubleshooting from a remote place. Advanced test and measurement tools such as virtual scopes and transient recorders, real "hardware probing" by transporting field-bus protocols through the Ethernet, control system independent access points to hardware components, etc. will facilitate this task. However, it appears unlikely that a remote expert is able to solve all technical problems

without the help of the on-site staff, e.g. to connect some hardware device with a remote instrument.

- An important issue is the communication between different control rooms or between on-site staff and remote experts. Support for an electronic logbook, video conferencing, voice recording, helmet cameras, worldwide pagers etc. have to be provided.
- The experimental groups are partners in a global accelerator network. The control and communication system has to account for a bi-directional information transfer between the control room of the accelerator and the experiment(s).
- It is important to record a large number of beam and accelerator events during operation. In a linear accelerator, pulse-by-pulse synchronization is indispensable. Sophisticated tools have to be provided for off-line data handling. The question of data reduction by proper triggering has to be addressed. Filter routines have to be specified guiding the experts. Tools to visualize and document logged data as well as to report results have to be implemented. In particular, high-energy physics experts have a huge experience in handling and analyzing a large amount of recorded data.

VI. Standardization vs. Accommodation

The collaborative approach of GAN tends to broaden the level of standardization which can be achieved. However, it is worthwhile to fight for standards. Maintaining the balance in the tension between standardization and accommodation is an important task. Driven by development of technologies the defining of standards must an evolutionary process. To keep this process transparent, a central steering body should be established which has to be careful while inventing standards. This process will be dynamic for 25 years or more. To cope with this fact, encapsulation of system components is recommended.

The working group identified some areas most applicable for standardization:

- Training and documentation
- Adminstration and security
- Interfaces and protocols
- Rules for updates and system changes.

Report from Working Group 3
Communication and Community Building

Participants:

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Vision, goals, and purposes

Question:

How to achieve a common vision and goal? Do we share the same goals and purposes? What are they?

Answer:

The GAN inspiration was the goal to build a Linear Collider as an international project, making the best use of world-wide competence, ideas, and resources. The vision is to do this in a way that fosters distributed centers of excellence in accelerator physics, particle science, engineering and technology, in all participating countries. The same idea could certainly be adopted by other projects as well. For clarity, the Linear Collider will herein be used as the example

The challenge is to extend this vision to individuals and laboratories. To bring the laboratories to make commitments, and thereby keep the culture of accelerator development (scientific and technical) alive in laboratories and universities. This is a major aspect of ``communication and community building".

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Site laboratory

Question:

Why would the site laboratory relinquish control? Must we break the symmetry by having a site laboratory?

Answer:
They would relinquish control for continued participation of the partners who built the accelerator sub-systems. Mutual trust is the critical element for this to be successful. Such trust can be built up during the commissioning period at the site.

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Organization

Question:

What are the possible organizational structures (between governmental financial shareholders and institutions), and which is the one best suited to the task? Which aspects of Project Management need to be centralized, and which should not? What are the risks and possible solutions? How to establish a mutually acceptable computer security policy? What is the process and what are the guidelines defining and dividing the tasks of building and operating the accelerator?

Answer:

The framework in which to discuss organizational structures, and the decision processes and guidelines, is the International Steering Group, with world community input such as suggestions from workshops like this. Ultimately, decisions must be made by the collaborating partners.

There are already examples of multi-laboratory accelerator projects, and particle physics experiments. There are many examples of distributed Project Management from which lessons can be learned, in balancing partner lab autonomy against successful integration. For example, in order to underscore the shared nature of the project, we suggest that there be no "host laboratory" but rather a "site laboratory" and that the Project Manager not be an employee of the site laboratory.

Certain organizational items, such as computer security, need to be addressed very early in the GAN process. Security aspects should be

included in prototype remote operation tests. Change control during construction of the ultimate facility will be the responsibility of its project management.
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Communications

Question:

How do we build and sustain trust and relationships? How to maintain informal and unplanned communications as the project size scales up?

Answer:

It is well known that distributed organizations need to build and maintain trust. Sharing working time together from the very beginning is a powerful agent in establishing this trust. This requires a mix of face-to-face interactions and the use of appropriate communication and collaboratory technologies. A number of tools should be investigated in the formation of the Linear Collider collaboratory. Some of the most exciting work is in industry, with many tools imminent. The new technologies enable more efficient use of face-to-face time, which nonetheless remains essential for community building. Remote and face - to - face interactions of all sorts should take place at all levels of the project.

A rich array of communication and collaboration tools are emerging, both as end applications from industry and as middleware toolkits from computer science research. Operating systems are incorporating many of these features as well. These tools support the full spectrum of situations, ranging from planned, structured activities like scheduled meetings to opportunistic interactions facilitated by general presence awareness of others. Further, improvements in networking and in compression algorithms mean that rich media like interactive video will be easy to exchange reliably over the internet. Appropriate suites of tools can be selected and configured so that users have the flexibility to interact with each other in a variety of ways, at many different scales and under many temporal arrangements.

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Operational evolution

Question:

For both institutions and individuals, how do you motivate long term involvement? How to manage the evolution from commissioning to operations and upgrades? Is there any clear transition between them?

Answer:
Producing exciting science will be the primary foundation for a successful frontier facility, of course. Technological challenges will also be important in maintaining interest throughout the entire community needed to make the enterprise a success.
The Linear Collider will be only the second such collider, and so its operation will always be exciting and challenging, through beam commissioning into full performance, and on to machine upgrades. Working on the frontiers of technology creates the need for a continuous upgrade culture. This culture needs to be distributed into sustaining engineering, and around the world.

There will need to be a large on site presence of the participants during installation and commissioning. This will be the opportunity for community and mutual interest building that will sustain interest through the transition from early commissioning through to the continuous upgrade period.

Maintaining excitement over the life cycle of the project is a challenge. We have to provide easy remote environments for operators and accelerator physicists, in order to keep activity levels high.

Important considerations, among many others, that need to be foreseen from the very beginning are: 1. A method of recording the commitments of the participating organizations so that, as individuals involved retire or move, their contribution is backfilled by their organization; 2. There needs to be a collaboration wide, shared mechanism for mobilizing the necessary manpower resources in the event of unusual conditions at the site needing rapid intellectual and/or physical response.

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Experiments and accelerators

Question:

What are the differences between experiments and accelerators? Should each institution preferably be motivated to collaborate on BOTH accelerator and scientific exploitation?

Answer:

Historically, the commitment for an experiment is geographically extended, whereas for accelerator physics it is largely focused at a single location. The concept of the GAN assumes that construction of the Linear Collider will follow the detector paradigm. As this represents a difficult cultural change for the accelerator community, we need to start the process of building up solid mutual understanding and trust as partners as soon as possible. Joint studies on remote operations can be a promising avenue in this direction.

Experiments are already moving in the direction of distributed operations (for example, CLEO and CMS). Both accelerator and experiments need constant care and improvement during operations.

Yes, institutions should be motivated to collaborate on BOTH accelerator and scientific exploitation. This provides the strongest motivation for long term involvement and interest.

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Remote operations community

Question:

What is the remote operations community? How is the operations group constructed? What is the role of multiple control rooms in maintaining centers of excellence in accelerator technology? What are these multiple control rooms?

Answer:

The remote operations community is those experiments, controls groups, accelerator physics group, vendors, workshop participants, et cetera, who are interested in demonstrating and developing remote operations capabilities at accelerators. The remote operations community overlaps the Linear Collider community -- there is considerable interest in remote operations outside GAN, as well as inside.

Some control rooms may be complete, others may invoke collaborative tools to just give virtual presence in a complete control room. These models can be adjusted to maintain involvement of operations and accelerator physics groups. These models need to be enumerated and evaluated. What does a virtual control room look like?

There is a lot of parallel remote operations activity in the experimental community. For example, how about joint accelerator/experimental demonstration projects, to promote mutual reinforcement in developing the methods ?

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Emerging technologies

Question:

What foundation technologies and infrastructures are needed for communication and community building? What can be learned about distributed environments from industry?

Answer:

The workshop series has to identify the needs of the GAN, and which of them will be met (or not) by emerging technologies. This will be an evolving process.

Foundation technologies, like the internet or the World Wide Web, are infrastructures that enable a suite of resources and tools to be built on top of them. Foundation technology development is happening in experimental physics, in industry, government, and in the military. Two technologies are potentially relevant here:

1) Grid technologies are specifically designed to promote collaboration and resource sharing in virtual organizations like GAN;

2) Industry frameworks such J2EE, .NET, and WebSphere promote enterprise wide collaboration.

The need here is to share resources in real time, which puts some demands on networks (for example, the notion of Quality of Service for packet delivery). There is an ongoing convergence on Web Services and existing Grid research developments -- research efforts appear to be maintaining industry interest. Remote control rooms and video conferencing are examples of tools that work on these foundations. Mechanisms for computer security, including such issues as authentication and authorization, must be built in from the ground up.

Internet middleware development is aimed at intermediate level tools which you can interface to your application.

An explicit part of this workshop series should be to evaluate existing and emerging foundation technologies, and to gain experience with them, in order to leverage them for the GAN. Significant effort must be invested by the accelerator community in developing, prototyping and deploying ``Grid enabled'' applications. This effort can to a great degree exploit the early leadership in this area exhibited by particle physicists.

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Standards

Question:

What language do we use? How do we establish the required glossary of terms?

Answer:

It seems clear that use of a single language for intra-collaboration communications would be advantageous. The choice of language would of course have to be made under the authority of the international constructing and operating organization. As a further aid to precise communication it would appear advantageous to develop an extensive glossary. Ultimately the authority for establishing the glossary would be the constructing organization. However, gaining some practice in constructing such a glossary could be helpful as part of a prototype experiment. Even within current operating organizations such a glossary can be useful. For example such a glossary has been developed at SLAC.

SLAC has developed a glossary of terms used at SLAC - called SLACspeak. Their experience indicates that the list of words and definitions is developed by individuals. What is needed is a pointperson who collects the definitions and edits them into a common format. Then there is the question of approval. The glossary can be published on a website and as a booklet. See http://www.slac.stanford.edu/history/speak.shtml for a discussion of the SLAC experience. See http://www.slac.stanford.edu/spires/slacspeak/ for SLACspeak itself.
It is hereby suggested that we have another discussion of the glossary at Shelter Island. The goal of that discussion is to identify the editor (or editors), and define the approval process (an Editorial Board?)

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Planning

Question:

What is the process to answer these questions? Are there projects we can do in the short term to prototype the GAN? What resources, analyses, research, and discussions need to be applied to prepare for Shelter Island?

Answer:

This workshop series is currently the process by which these questions get answered. However, of necessity, our mandate is self generated. It will be an early task of any appropriately established international authority to review these matters and resolve them quickly, aided it is to be hoped, by experience we develop in the mean time.

Potential trials of remote operations implementations need to be investigated and proposed, both inside and outside the Linear Collider community.

For example, remote operations at

-- ATF (KEK)
-- CMS (CERN)
-- LINX (SLAC)
-- FNPL (FNAL)
-- RHIC (BNL)
-- SNS (ORNL)
-- TTF (DESY)

could be discussed. The emphasis should be on testing beyond what has already been achieved. Current and past projects should be analyzed for guidance. For example, TTF has operational experience already, and the LHC experiments are making plans for remote operations. An accelerator upgrade project might be a strong candidate.

Even at this early stage we need to discover an appropriate documentation style -- virtual team, virtual work -- that is flexible enough to track an adaptive organization.

There are numerous models of the connection between partner laboratory remote control rooms and the accelerator. These models need to be enumerated, studied, and evaluated.

Appendix I. Workshop Agenda

Thursday, March 21, 2002

08:30	Welcome	Maury Tigner
08:50	Announcement of the Sept. 17-20, 2002 "Workshop on Remote Operation of Accelerator Facilities"	Steve Peggs
	Plenary Session I	Convener: Nobu Toge
09:00	"What is a Global Accelerator Network?" Review of ICFA subgroup report: "Status Report of the Inter-Laboratory Task Force On Remote Control"	Ferdinand Willeke
09:40	Review of ICFA Subgroup 1 report: "General Considerations and Implementation of a Global Accelerator Network"	Albrecht Wagner
10:20	Break	
	Plenary Session II	Convener: Steve Peggs
10:40	Experience at SPARC (Space Physics and Aeronomy Research Collaboratory)	Gary Olson
11:20	TTF Remote Operation	Kay Rehlich
11:55	CLEO Remote Operation	Klaus Honscheid and Tim Wilksen
12:35	Lunch	
	Plenary Session III	Convener: Karen White
13:30	Linear Collider vs Storage Ring Collider Control Requirements	Tom Himel
14:00	Standardization vs. Accommodation	Steve Peggs
14:40	Working Group Organizers' Charges to the WG's	Ferdinand Willeke, Reinhard Bacher, Steve Peggs
15:10	Break	
15:30–17:30	Working Group Sessions	

Friday, March 22, 2002

09:00	Working Group Sessions	
10:10	Break	
10:30	Working Group Sessions	
	Plenary Session IV	Convener: Ray Helmke

12:00	Status Reports from Working Groups	Ferdinand Willeke, Reinhard Bacher, Steve Peggs
12:30	Lunch	
13:30	Working Group Sessions	
15:30	Break	
15:45-17:30	Working Group Sessions	
18:00	Reception	
18:45	Banquet	

Saturday, March 23, 2002

	Plenary Session V	Convener: Albrecht Wagner
09:00	Working Group Summaries	Ferdinand Willeke, Reinhard Bacher
10:30	Break	
	Plenary Session VI	Convener: Albrecht Wagner
10:50	Working Group Summaries	Steve Peggs
12:00	Overall Summary	Maury Tigner
12:30	Adjourn	