THE GLOBAL ACCELERATOR NETWORK – GLOBALISATION OF ACCELERATOR OPERATION AND CONTROL

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Abstract

The Global Accelerator Network (GAN) is a proposed model to design, build, operate and maintain a future large accelerator by partners of an international collaboration. This novel approach has many legal, sociological and technical issues. This paper will describe the general ideas of the GAN model and report on first results of a workshop series recently established to form a worldwide community and to discuss the various aspects.

1 INTRODUCTION

Traditionally, high energy particle accelerators have been built and operated in three different ways:

- National or regional facilities (for small and medium-size projects): built and operated by the host country or region.
- HERA - model (for large projects): planned and reviewed by an international collaboration; built by a host laboratory with "in-kind" contributions from the collaboration; operation of the facility is the responsibility of the host laboratory.
- CERN - model (very large projects): common funding for construction and operation in the frame of an international organization.

The cost and size of future very large accelerators such as a TeV or multi TeV e+e-collider, a multi TeV hadron collider, a neutrino factory or a muon collider will most likely exceed the resources of a single region. In contrast to the CERN – model, one alternative to build them is via the framework of an international collaboration meeting the following challenges:

- Maintain and nurture the scientific culture of the participating laboratories,
- Maintain the visibility and vitality of each partner.

The solution could be the Global Accelerator Network (GAN) proposed by A. Wagner [1] in 1999 who was inspired by the operation model of large particle physics experiments.

2 BASIC GAN IDEAS AND BENEFITS

The GAN framework of an international collaboration is based on long-term agreements. Its basic concept provides the following benefits for the collaborating partners

- It allows the designing, building and operating a new accelerator facility collaboratively with equal partners. The accelerator would be built at the site of an existing laboratory to benefit from available experience, manpower and infrastructure. However, the accelerator is removed from most of the collaborating institutions. Yet the facility will be a common property of the collaboration partners.
- It allows the partners to take responsibility for certain components of the project designed, built and tested at home before being delivered to the host site and operated as well as maintained from home after delivery.
- It allows retention of most of the manpower at the partner institutions, except during periods of installation and overhaul. Component maintenance, operation and development would be carried out as much as possible at the home institutes.
- It allows participating institutes to continue important activities at home while being actively engaged in a common project elsewhere.
- It allows using and maintaining the experience and special knowledge of the participating laboratories.
- It allows integrating and sharing scientific and technological knowledge, ideas and resources.

All the benefits listed above will contribute to facilitate the thorny problem of site selection for new large accelerator facilities.

3 THE GAN OPERATION MODEL

The GAN operation model can be characterized by extensive remote operation of the facility and remote participation according to a multi-triangle model (Fig. 1).

- It is proposed that a small core team of experts consisting of employees of the collaborating laboratories will be stationed on the site of the accelerator for repair and maintenance work.
- Experts from different laboratories will support and guide the local team remotely. These experts will be employees of their corresponding home laboratories and responsible for periodical technical monitoring, error analysis, R&D as well as planning of repair and maintenance.
- Identical copies of control rooms, e.g. located on the sites of existing accelerator laboratories, will be used to operate the GAN accelerator facility. The members of the operation team will be employees of the corresponding laboratories. A coordinating management team with members' form the collaborating institutions will organize and supervise operations.

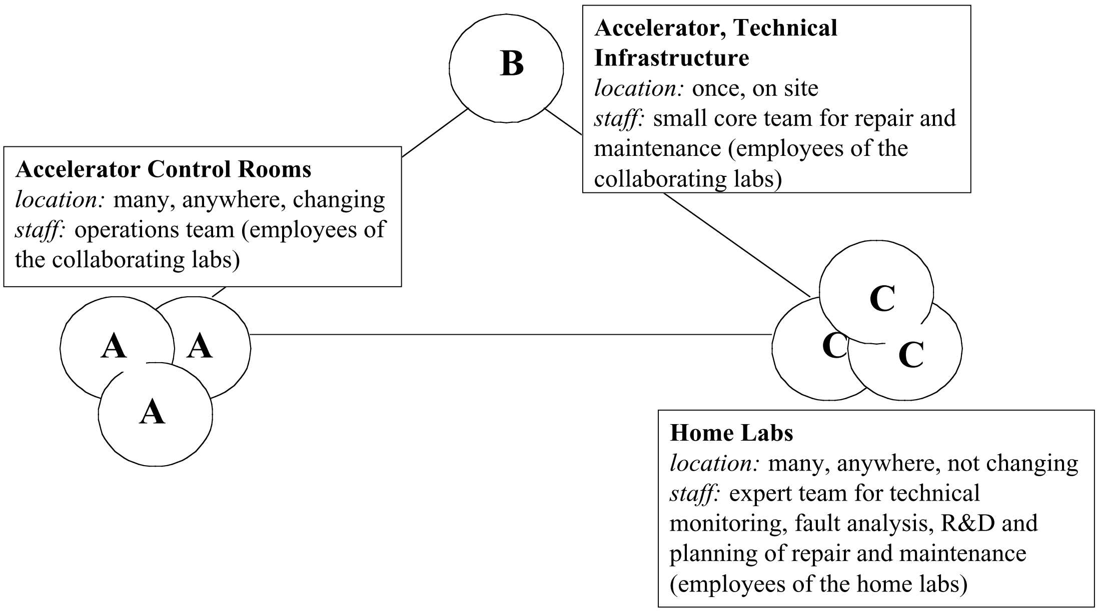

Figure 1: The GAN operation model (for explanation, see section 3)

4 CRUCIAL ITEMS ASSOCIATED WITH THE GAN APPROACH

During the past year, crucial items associated with the GAN approach have been identified and discussed at various occasions:

- ICFA Task Force report to study the GAN proposal and its implications, December 2001 [2]
- Workshop on “Enabling the Global Accelerator Network”, Cornell, March 2002 [3]
- Workshop on “Remote Operations”, Shelter Island, September 2002 [4]

The items discussed can be sorted into two categories, (1) human, and (2) technical aspects.

4.1 Human Aspects

Obviously the human aspects are most controversial and the most urgent as well as the most difficult to solve. Though, stamped by different histories or laboratory cultures, discussions between operator crews as well as between development engineers or between managers have already begun in order to find answers for such questions as:

- How can we achieve the desired “corporate identity” and a common culture?
- How do we adopt different cultures and experiences, e.g. of accelerator operations crews? What are the implications for the home laboratories and the individuals? How do we keep people involved and interested?
- How do we establish mutual trust, “personal connections” and information exchange mechanisms?
- How do we make decisions and achieve a “flexible consensus”?
- Why would the site laboratory relinquish control?
- Which language should we use?
- How much manpower is needed permanently on site?
- How much manpower is needed in the home laboratories?
- Which are the necessary qualifications of the staff?
- etc.

4.2 Technical Aspects

The workshops have demonstrated that it is much less difficult to agree on answers of questions concerning the technical realisation such as:

- How do we perform a common technical management (rules, procedures, standards, criteria, etc.)?
- It is expected that on about 20 occasions per year the presence of remote experts on site will be required. To get the expert in will cause a substantial downtime of the accelerator operation. How do we solve this so-called “1%-problem”?
- How do we minimize accelerator downtime in general? Is the availability of technical components high enough?

- What are the requirements for hardware as well as software components?
- What is the appropriate control system architecture? How do we fulfil the different user's needs? How do we balance standardization versus accommodation requests?
- Is the available network bandwidth sufficient?
- Are present securities standards appropriate?
- Is the performance of modern communication technologies sufficient?
- etc.

It is the common understanding that operation of an accelerator according to the GAN model is technically feasible. The need to establish a steering body for standardization and coordination is widely acknowledged.

4 FIRST STEPS TOWARDS A GAN

The key elements of the GAN approach are remote control, remote diagnostics and remote participation. This kind of remote involvement can be facilitated or supported using various tools and standards.

- Modern communications technologies and tools as well as security standards allow operating from multiple control rooms, attending meetings or facilitating error search and maintenance from a remote site. The performance of advanced video conferencing tools such as Access Grid (fig. 2) [5], white and smart boards, display walls, high quality audio transmission, modern secure authentication and authorization mechanisms, virtual private networks etc. has been discussed.
- Modern collaborative tools, information management systems or training material will support the common work. It is the common understanding that electronic logbooks (fig. 3), workflow charts, common data bases as well management or oversight tools etc. will be widely used among the collaboration. Grid technologies and industrial frameworks will become more and more important.
- Of great importance will be an appropriate system design for all kind of accelerator components. Agreements on modularity (fig. 4) and interfaces, robustness, data acquisition and streaming, local intelligence, redundancy, high level of availability etc. will be necessary without imposing too stringent limits to the developers of hardware as well as software.

At the workshops in Cornell and on Shelter Island, experiments to prove particular aspects of the GAN approach have been discussed. The aims of these experiments are to gain technical experiences as well as to support a global community building. Among others, proposed examples are:

- SNS s.c. RF commissioning (partners: TJNAF, and LANL): gain experience and assist s.c. RF commissioning
- Coherent beam-beam interaction studies (partners: BNL and FNAL): test remote operation of beam studies from another laboratory
- Emmittance studies (partners: DESY, Cornell, Ohio State, University and University of Michigan): perform remote machine shifts
- Virtual control room (partners: CMS and FNAL): test a collaborative environment
- Virtual coffee corner (partners: PSI, TJNAF, LBNL, BNL, ORNL and KEK): explore videoconferencing technologies and support community building
- etc.

Figure 2: Access Grid [5] examples

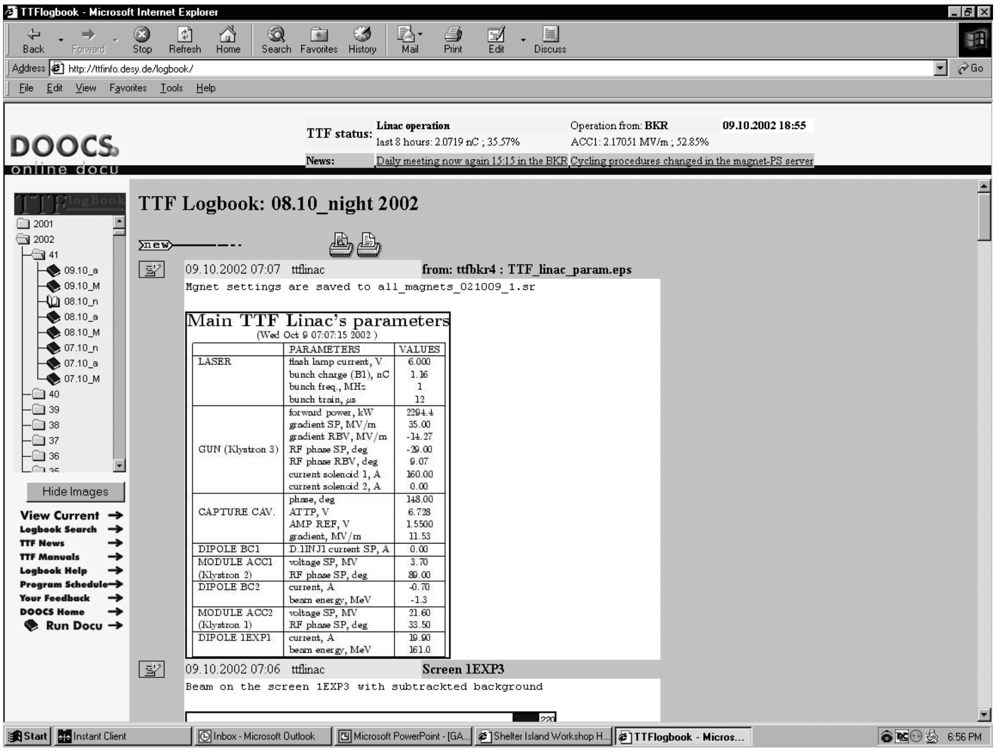

Figure 3: Screen shot from the Tesla Test Facility electronic logbook [6]

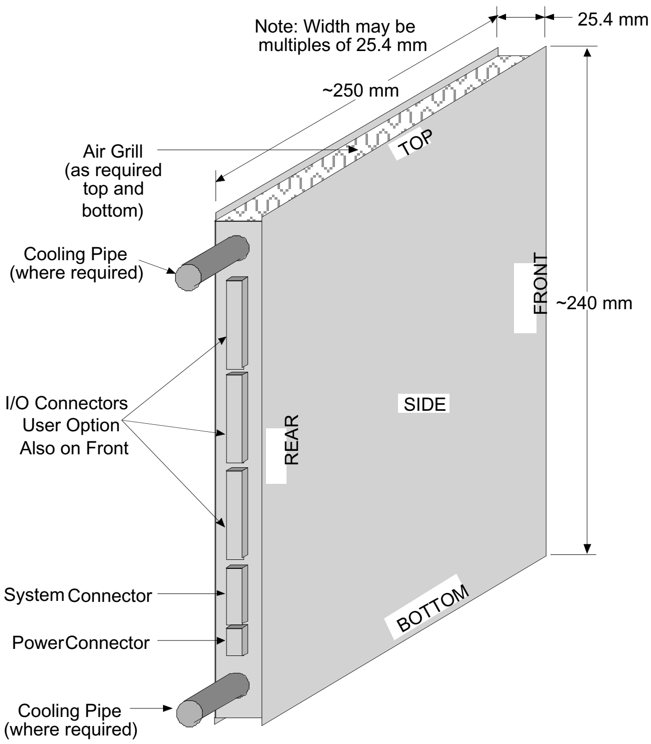

Figure 4: Concept of a back plane less electronic module (VME Standards Organization) [7]

5 THOUGHTS ON ACCELERATOR CONTROLS IN A GAN ENVIRONMENT

The control system of an accelerator facility operated and maintained by a collaboration organized in a GAN has to support the remote as well as collaborative nature of the common involvement of the participating laboratories. Challenges to be met are:

- How can we fulfil the needs of the different users of a control system (operators, scientists, hardware experts, programmers, system experts etc.)?
- Different laboratories have different experiences and approaches. How can we deal with diversity without generating a disastrous fragmentation of the control system?
- How can we sustain and up-grade the control system over a period of 20 years?
- etc.

The design features of an accelerator control system in a GAN environment have not yet been discussed in great detail. In the following, some building blocks of a control system are summarized which could satisfy the requirements mentioned above:

- Distributed system: mainly implemented locally on site, with global extension for remote operation and participation
- Layered or structured framework architecture with a transparent separation of tasks: front-end device or resource layer, visualization or GUI layer, communication layer, software bus or middleware
- Web-based clients for visualization: powerful GUI framework, wizards and rendering tools
- Common, object-oriented software bus or middleware with business logic, virtual devices and interfaces: platform independence, providing a flexible and appropriate model for abstract device properties and methods
- Intelligent front-end devices: standardized interface to software bus, neither "secret code" nor "hidden variables", support of different hardware standards (VME, PCI etc.) and software platforms (Linux, Windows, real-time OS etc.), support of industrial lab automation software packages, providing wizards, generators and simulators
- Multiple interfaces: interfacing complete industrial supervisory systems (e.g. cryogenic process control systems), interfacing complex scientific-oriented analysis software (e.g. MatLab), interfacing local Web servers for maintenance purpose
- Efficient communication protocols based on modern internet standards: remote method invocation, messaging services, unicast and multicast transmission
- IP-based networking: predominant use of structured Ethernet, only limited use of field buses

6 REFERENCES

[1] A. Wagner, Accelerators to Span the Globe, CERN Courier, June 2000, p.19 (http://www.cerncourier.com/main/article/40/5/1)

[2] http://www.agsrhichome.bnl.gov/RemOp/docs/icfa_tforce_reports.html

[3] http://www.agsrhichome.bnl.gov/RemOp/docs/cornell_ final_report.pdf

[4] http://www.agsrhichome.bnl.gov/RemOp/

[5] For reference see [4]: D. Agarwal, J. Olson, "Collaboration Tools for the GAN", Workshop on "Remote Operations", Shelter Island, September 2002

[6] For reference see [4]: K. Rehlich, "GAN @ TESLA TEST Facility", Workshop on "Remote Operations", Shelter Island, September 2002

[7] For reference see [4]: R. Larsen, Engineering Designs for Remote Operations: Summary Report", Workshop on "Remote Operations", Shelter Island, September 2002