Introduction to the Global Detector Network

J. Mnich
DESY, Hamburg, Germany

An international working group on the Global Detector Network has been charged with the task to identify and address questions related to the fully remote control of large detectors at the Linear Collider. To continue the truly international enterprise beyond the design and construction phase the detector like the accelerator should be operated from different laboratories around the world. This ambitious goal will require careful design of the detector and its infrastructure. This article describes some of the issues raised at previous workshops and summarize the discussions on this topic.

1. CONTEXT OF THE GLOBAL DETECTOR NETWORK

At this workshop design studies for a linear e^+e^--collider (LC) in the energy range $0.5-1$ TeV are discussed which are going on in different regions of the world. The competing approaches are now evaluated and the hope is that soon after a common design is proposed the construction of the accelerator will begin. The LC is a huge project which requires the combination of the financial and manpower resources of all regions and a tight collaboration of the laboratories. It is evident that worldwide only one machine can be constructed. To keep the laboratories in the region not selected as site of the LC intact and alive the importance of the accelerator site should be reduced to a minimum. For this reason the idea of the Global Accelerator Network (GAN) [1] has been proposed which should lead to a global collaboration in the construction, commissioning and operation of the large accelerator facility.

The same arguments apply also for the LC detectors which led to the formation of a worldwide working group on a Global Detector Network (GDN) [2, 3]. The charge of this group is to prepare recommendations to allow to operate the detectors from different laboratories around the world.

High energy physicists have large experience in designing, constructing and operating large detector in large international collaborations. However the goal of the GDN project goes beyond that. The international collaboration should be extended to the point that the complete detector can be remotely operated from control rooms in different regions of the world using modern computer and communication technology. The ambitious goal is that the need for physical interventions locally at the experiment should be reduced to an absolute minimum.

This requires that equivalent control rooms with the same rights, duties and technical capabilities exist in different parts of the world (Fig. 1). In addition to the monitoring and diagnostic tasks possible to some extend from remote sites already for current experiments the GDN must offer the capability of active remote control and intervention which necessitates specific design of the detector electronics and its monitoring systems.

2. ISSUES FOR THE DETECTOR DESIGN AND OPERATION

The GDN working group was launched at the ECFA/DESY meeting in November 2002 at Prague. Since then reports from large modern experiments which address some GDN related questions were at the center of discussions in several ECFA/DESY workshops and the international IEEE conference 2003 at Portland. Among the issues important for the realization of the GDN are:

- Detector design:
  To permit the full remote control of the experiment in particular the data acquisition and slow control systems of the detectors must be carefully designed from the beginning. The status of each component must be

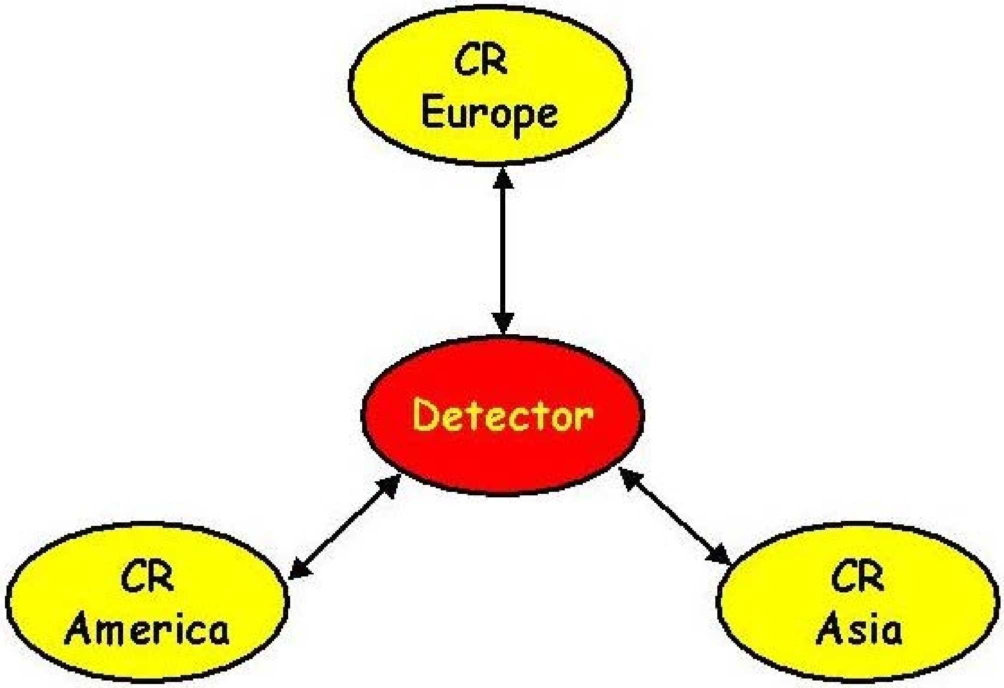

Figure 1: Illustration of bi-directional monitoring and active control of the detector in the GDN framework from control rooms (CR) in different regions of the world.

accessible through control computers making optical status lights superfluous. Even in case of major failures of a component it must be removable remotely from the data acquisition such that it does not interfere with the rest of the system. Only the physical replacement and repair of broken modules is left to local intervention crews.

- Technical questions:
  The GDN framework will require extensive data transfer between the detector and the distant control rooms. The type and amount of information to be exchanged has to be evaluated in order to determine the necessary bandwidth for data link. As the expert staff will be dispersed all over the world excellent virtual conference tools are mandatory. Likewise high quality video and audio communication is required to describe and discuss problems and to supervise items not directly accessible to computers like for instance some environmental conditions in the detector cavern.

- Safety and security:
  The data link between the detector and the control rooms must be absolutely stable and reliably. It is at the center of the GDN and the safe operation of the experiment depends on it. The link must be externally secure that is that unauthorized access by strangers must be inhibited. Likewise detector access by collaborators must be controlled to prohibit inopportune actions. It is believed that these issues require an isolated dedicated network.

- Social and physiological questions:
  Aside from the above more technical issues the envisaged remote detector operation raises also questions related to the human beings involved in the experiments. An example is the problem how to make an operator feel responsible for a complicated and expensive but very distant apparatus in the same way as if he would be physically close to it? The question of responsibility in case of accidents might create legal problems between the involved countries which need to be settled well before the commissioning of the experiment. The training

of the operators must be organized such that they acquire the necessary skills even if they do not have physical access to the detector itself. And finally the GDN requires much more than today's high energy physics collaborations that common rules in different cultural environments are evaluated and applied.

Having these and other questions in mind it remains open if it is desirable to push the GDN aspect of remote control to the technological limit. Perhaps the preparative discussions in the GDN workshop and the acquisition of experience during the design and construction phase of the detector will show that a certain amount of responsibility must always stay with crews on the detector site.

3. EXPERIENCE FROM LARGE INTERNATIONAL PHYSICS EXPERIMENTS

Several aspects of the above GDN related aspects have been addressed by large modern experiments in high energy physics and other sciences. Reports on past experience and future plans from HERA, Tevatron and LHC experiments but also from the AMS01 experiment operated on the space shuttle have been given at the workshops. The presentations can be found at [2].

Already today at running experiments like D0 at the Tevatron online detector monitoring is routinely done from overseas sites. However, so far no active remote control has been implemented in large collider experiments

Future experiments like at the LHC will have some of the additional capabilities required for the GDN. An example is the data acquisition system, in particular the high level trigger filter farm, of the CMS experiment [4] which will include extended possibilities for remote interventions by software. An important point for the design to be learned here is the hierarchical structure of the system and the redundancy of components. To improve efficiency this redundancy should increase with the component's position in the DAQ and control hierarchy.

Space experiments like AMS rely heavily on very reliable and proven data links. The GDN will require even better stability and a much higher bandwidth as currently available.

4. CONCLUSIONS

The first goal of the studies is to comment on the feasibility of the GDN and to set up guidelines for the detector design. The GDN capability is an integral part of the detector and must be incorporated in the design. It is desirable that the GDN functionalities are further developed and tested in test-beams of sub-detectors and applied from the early running-in phase of the complete experiment up to the later daily routine operation.

The capability of a complete remote control of a complex high energy physics experiment in the GDN sense will certainly increase the complexity of the apparatus. It will also result in larger costs as additional components and redundancy are required. On the other hand the GDN offers the chance that once more high energy physics can become a model for science and other fields in global collaboration and the application of advanced technologies.

References

[1] URL: http://gan.desy.de/GAN/index.jsp

[2] URL: http://www-hep.fzu.cz/gdn/

[3] The convenors of the GDN working group are:
America: Mike Hildreth (mikeh@undhep.hep.nd.edu), Rick van Kooten (rvankoot@indiana.edu),
Asia: Keisuke Fujii (keisuke.fujii@kek.jp),
Europe: Joachim Mnich (mnich@cern.ch), Vaclav Vrba (vrba@fzu.cz)

[4] CMS Data Acquisition & High-Level Trigger Technical Design Report, LHCC 02-26, CERN.