Detector Simulation Support at the SSC Laboratory

Lee A. Roberts

SSC Laboratory\textsuperscript{1}, 2550 Beckleymeade, Dallas, TX 75237, USA

Computer simulation of the GEM and SDC detectors is an important component of the design of these scientific instruments. The SSC Laboratory has provided substantial UNIX hardware and software programming support for detector simulations by collaboration physicists. This paper presents an overview of the detector simulation support provided by the SSC Laboratory and user experience with these systems.

Introduction

Within the past three years, the SSC Laboratory has developed a significant computational resource devoted to the design and simulation of high energy physics detectors. GEM and SDC collaborators have available a sizable collection of detector simulation tools on powerful RISC/UNIX architectures. We shall examine the present support capabilities and consider user experiences of this evolving facility.

SSCL Support

The Physics Detector Simulation Facility (PDSF) has been developed to meet the needs of the GEM and SDC collaborations in design and simulation of their detectors. In addition, local and remote collaborators require support on their individual RISC/UNIX workstations.

Hardware

Approximately 3000 MIPS of computing resources are available in the PDSF. The following PDSF systems are available for detector simulation.

- 4 Silicon Graphics 4D/360S data servers, each with 128 MB memory and 24 GB disk.
- 30 Sun SPARCstation 2 compute servers, each with 32 MB memory and 1 GB disk.
- 32 Hewlett-Packard 9000/720 compute servers, each with 32 MB memory and 1 GB disk.

All systems are interconnected via FDDI and are available to collaboration physicists via local- and wide-area networking. Details of the PDSF architecture are presented elsewhere in these proceedings\cite{1}.

Local SSCL physicists use a variety of RISC/UNIX workstations. Most of these CPUs are binary compatible with one of the system architectures in the PDSF. However, SSCL physicists also use DECstation and IBM RS/6000 workstations. External GEM and SDC collaborators use a variety of these RISC/UNIX workstations. In addition, VAX/VMS systems continue to be widely used throughout the collaborations, although such capability is limited at the SSCL.

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Software

Software support for common codes such as the CERN Program Library and Monte Carlo generators as well as support for GEM- and SDC-specific codes is provided by the SSC Laboratory. A variety of additional codes have been provided through the efforts of GEM and SDC collaborators.

Common software codes are supported by the Applications Support group within Physics Research Computing. Supported codes include the CERN Program Library[3], GEANT[4], CMZ[5], ISAJET[6], HERWIG[7] and Lund Monte Carlos (PYTHIA/JETSET)[8]. These codes are supported on five RISC/UNIX architectures: Silicon Graphics, Sun, Hewlett-Packard, DEC and IBM. Support for the first three architectures is directly required by the PDSF; the other architectures are required by local SSCL physicists and by external GEM and SDC collaborators. Limited support is also provided for VAX/VMS systems.

All common software is provided on each of the PDSF architectures. For local SSCL workstations, common software is available via NFS or compressed “tar” archive format for each architecture. External SSC collaborators are provided software via compressed archives or tapes, subject to software licensing restrictions. Consulting assistance is provided for both local and remote users. Applications Support personnel actively collaborate with software authors to resolve difficulties.

Additional software is provided by the Systems Integration and Development group within Physics Research Computing. Among the software utilities provided by this group are the Network Queuing System (NQS), Cooperative Process Software (CPS)[9] and Data Management System (DMS). NQS provides a distributed queuing system across the multiple workstations of the PDSF and allows users to distribute jobs to available workstations. CPS provides an application programming interface for event-level parallelization of high energy physics simulation and analysis tasks, allowing users to take advantage of multiple CPUs within a single job. DMS provides storage and retrieval of data sets through 8mm tape robots. Details of the DMS architecture are presented elsewhere in these proceedings[2].

Applications Support personnel also provide assistance to the GEM and SDC collaborations in the configuration, maintenance and distribution of their collaboration software. Both GEM and SDC have selected the SSC Laboratory to be the central repository of their collaboration-wide software.

SDC’s general simulation package, SDCSIM, is actively supported by the SDC Support group within Applications Support. SDCSIM is a GEANT-based detector simulation which provides a uniform structure across the SDC collaboration. SDCSIM is composed of approximately thirty packages representing simulation, reconstruction and user codes. Code is written in FORTRAN-77 with minimum extensions. Machine dependencies are absorbed in the SDC-SHELL framework or the CERN Program Library. PATCHY is used for library management. Local SSCL support includes coordination, building, testing and distribution of SDCSIM on the five above-mentioned RISC/UNIX and VAX/VMS architectures. Remote users are responsible for non-automatic “pull” distribution from official sources at the SSCL.

GEM’s general simulation package, FAST1, has been developed as a fast simulation of the GEM Baseline 1 detector. Parameterized descriptions of each subdetector have been developed from GEANT-based subdetector simulations. Members of the GEM Support group within Applications Support have been actively involved in the development of the FAST1 simulation. STDHEP[10] event generator format has been selected as the FAST1 standard, providing a common, well-defined interface to several generators. FAST1 code is written in FORTRAN-77 plus common extensions and is managed using the RCS revision control system.
User Experience

Most users have been quite successful when running detector simulation programs on the PDSF. Users approach the PDSF with a variety of computing backgrounds ranging from VAX/VMS to IBM VM/CMS to UNIX. These users have, with varying degrees of ease or difficulty, learned how to work within a multi-vendor RISC/UNIX environment. Given the usual complement of common software tools—physicists are actively designing and simulating SSC detectors.

Both GEM and SDC are at early stages in the development of their full detector simulations. Neither is presently running full-scale production of Monte Carlo events. As a result, PDSF usage is primarily by individual users, who submit a small number of uniprocessor-based jobs to multiple workstations within the PDSF. Parallel execution techniques for GEANT simulations using CPS or other remote procedure call mechanisms were developed for use on the PDSF, but these techniques are not presently used.

Detector simulations on the PDSF have ranged, as expected, from simple to complex. Event generator simulations may be easily combined with user-written analysis code and histogramming packages to create fast simulations. GEANT-based simulations may be moved among RISC/UNIX machines with little difficulty. Users have been able to transport existing simulations from their home institution to the PDSF to take quick advantage of the available power. In addition, CALOR89[11] and LAHET[12] simulations have been ported by GEM and SDC collaborators to run on the PDSF. Such codes provide detector simulation capabilities complementary to the popular GEANT-based description. LAHET simulations are presently being performed for both GEM and SDC to calculate radiation activation in the detectors.

Users have, of course, encountered difficulties on the PDSF. UNIX offers a multitude of choices for editors, window manager configurations and compiler options—and these choices vary among architectures. Quota systems for disk or CPU do not exist on all UNIX systems and have not been implemented on the PDSF, leading to occasional difficulties with full filesystems or runaway processes. Use of NQS for batch queuing has been on a voluntary basis; many users prefer UNIX background execution of jobs, which often overloads individual workstations.

SDC

SDC collaborators have made extensive use of the PDSF for SDCSIM GEANT simulations. An estimated 70–80% of SDC usage of the PDSF is for SDCSIM calculations. External SDC collaborators make extensive use of SDCSIM as well as individual or small-group efforts which have been externally developed.

SDC simulation usage has been concentrated on the Silicon Graphics and Sun components of the PDSF. This represents the initial components of the PDSF and provides greatest compatibility with the Sun(-clone) workstations used by the SSCL SDC group.

GEM

The GEM collaboration is much younger than the SDC collaboration. As a result, GEM simulation has consisted of less formal, individual or small-group efforts concentrating on the development and understanding of detector subsystems. Numerous event generator simulations have been utilized. Detector subsystem efforts have also made extensive use of the PDSF for their GEANT-based simulations.

The GEM FAST1 simulation effort was developed to provide a fast, coherent simulation to study physics processes in the whole GEM detector. In view of the shorter (than SDC) time to produce a letter of intent and a technical design report, it was recognized that a physics simula-
tion which could analyze high statistics samples much faster than a complete GEANT simulation was needed. FAST1 combines subdetector parameterizations developed from GEANT-based subdetector simulations into a coherent framework for use in simulation of physics processes.

A full GEANT simulation of the GEM detector is in preparation. Several independent GEM GEANT simulations presently exist. Preliminary efforts are underway to organize and merge appropriate segments of these simulations into an official GEM GEANT simulation.

GEM simulation usage has emphasized the Hewlett-Packard and Sun components of the PDSF. This reflects the reconfiguration of the PDSF to use these systems as compute servers and provides the greatest compatibility with the HP workstations used by the SSCL GEM group.

D0

A group of SSCL physicists has recently joined the D0 experiment at Fermilab. D0 has a serious need for detector simulation capability; the resources of the PDSF provide an opportunity for SSCL physicists to make an immediate contribution to D0. D0GEANT is presently running on the Silicon Graphics processors in the PDSF. The D0 group at the SSCL plans to port D0GEANT to the Hewlett-Packard workstations in the PDSF to take advantage of their processing power. In addition, analysis of D0 data is anticipated on the PDSF.

Conclusions

The GEM and SDC collaborations are actively designing and simulating their detectors using the hardware and software support provided by the SSC Laboratory. Physicists are working within the heterogeneous RISC/UNIX environment provided by the PDSF and their local workstations. Users and system support personnel are working together to resolve system difficulties and provide a convenient user/physicist interface.

References

[8] H.-U. Bengtsson and T. Sjöstrand. PYTHIA 5.6, University of Lund and CERN/TH.