SuperB Simulation Production System

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Abstract. The SuperB asymmetric $e^+e^-$ collider and detector to be built at the newly founded
Nicola Cabibbo Lab will provide a uniquely sensitive probe of New Physics in the flavor sector of the Standard Model. Studying minute effects in the heavy quark and heavy lepton sectors requires a data sample of 75 ab\textsuperscript{-1} and a peak luminosity of $10^{36}$ cm\textsuperscript{-2} s\textsuperscript{-1}.

The SuperB Computing group is working on developing a simulation production framework capable to satisfy the experiment needs. It provides access to distributed resources in order to support both the detector design definition and its performance evaluation studies. During last year the framework has evolved from the point of view of job workflow, Grid services interfaces and technologies adoption. A complete code refactoring and sub-component language porting now permits the framework to sustain distributed production involving resources from two continents and Grid Flavors.

In this paper we will report a complete description of the production system status of the art, its evolution and its integration with Grid services; in particular, we will focus on the utilization of new Grid component features as in LB and WMS version 3. Results from the last official SuperB production cycle will be reported.

1. Introduction

SuperB [1] is an international collaboration aimed at the construction of a very high luminosity asymmetric $e^+e^-$ flavour factory with a two order of magnitude increase in peak luminosity with respect to current colliders. The machine and the detector will be built at the newly founded Cabibbo Lab [2] near Rome.
The computing efforts are currently devoted to support the detector design and data analysis and to a R&D program aimed at the definition of the experiment computing model [3]. This work aims at both these objectives.

The availability of reliable tools for simulation is crucial in the present phase of the design of both the accelerator and the detector. The background rate at the sub-detectors needs to be carefully assessed for each proposed accelerator design, and, for a given background scenario, the designs of the sub-detectors themselves must be optimized to obtain optimal performance.

SuperB simulations are currently a detailed Geant4-based [4] Full Simulation and a parametric Fast Simulation [5], which relies on simplified models of the detector geometry, materials, response, and reconstruction to achieve an event generation rate a few orders of magnitude faster than is possible with the Full Simulation, but with sufficient detail to allow realistic physics analyses.

A huge number of Monte Carlo simulated events are already needed to support the detector studies for the experiment TDR. Such a production is way beyond the capacity of a single computing farm so it was decided to design a distributed model capable of fully exploiting the existing HEP world wide Grid computing infrastructure and to develop a Simulation Production System in order to manage the Monte Carlo production cycles.

A prototype of the latter is described in Ref. [6]. This paper presents a complete description of the production system design and workflow, its integration with Grid services for submission and monitoring and the latest implementation of the functionalities used in production.

2. Distributed Architecture and Infrastructure

The LHC Computing Grid (LCG) architecture [7] was adopted to provide the minimum set of services and applications upon which the SuperB distributed production system has been built. Authentication and authorization is provided by VOMS service [8], LFC [9] is the file catalog, WMS [10] is used for brokering purpose and for Grid flavor interoperability features, transfers are done via Lcg-Utility, GANGA [11] is the submitting interface.

The SuperB distributed computing infrastructure, as of May 2012, includes several sites in Europe and North America. About thirty sites have been enabled for the SuperB Virtual Organization, among which four are Tier1 and 16 Tier2. EGI and OSG Grid flavour resources are available at present time.

3. System Design

An automated submission procedure and rich monitor features are of the utmost importance in order to speed up the production manager workflow completion, to keep data and metadata consistent, and to provide an easy-to-use interface for non-expert users. As a matter of fact, the major hurdle in accessing the Grid infrastructure for non-expert users is given by its intrinsic complexity and their lack of expertise. To accomplish this task, the simulation production system heavily relies on a bookkeeping database, storing both application-specific and infrastructure metadata, which is tightly coupled with a Web-based user-interface (WebUI).

The first makes available to the users information on the execution status of jobs and their specific meaning and parameters, and contributes in orchestrating the submission mechanism. The latter provides job submission management for Full Simulation and Fast Simulation, bookkeeping database interactions and basic monitoring functionalities.

The bookkeeping database is implemented with PostgreSQL rDBMS in a centralized way, the WebUI in PHP and JQuery. The database interactions with the submission portal and the job in execution on the WN are managed by a direct interface to PostgreSQL or a RESTful interface (with X509 proxy-certificate cipher-encryption auths), respectively.
4. Job Workflow

The structure of services and job workflow follow a semi-centralized design, as shown in figure 1: job management service, bookkeeping database and default storage repository are hosted in a central site. Jobs executed into remote sites update the bookkeeping database with status, logging and timing information and transfer their output back to central repository or to a predefined site, discriminating on execution metadata.

The system requires a proper configuration of the remote Grid sites in terms of software installation and, at present, transfer of simulation input files.

From the point of view of Grid services, job submission path is determined by a direct routing to selected site CE via WMS service, submission method is limited to bulk. The inclusion of WMS service into the job workflow permits to exploit Grid flavor interoperability features. The job JDL file do not include data handling management neither customization in terms of JobType. Data handling operation relies on SRMV2 protocol implemented by LCG-Util layer permitting a transparent interaction with heterogeneous site SE storage management systems. Authentication and file catalogue are respectively managed by VOMS and LFC services.

Job submission management is delegated to Ganga system. Various studies and configuration tests have been performed with the aim of customize Ganga functionality to be able to work as a simple and efficient submission engine. The lines of intervention can be summarized in: unused sub services deactivation, setup bulk as unique submission method, Grid submission information collection.

A Ganga specific script has been developed to permit runtime customization and site specific JDL file generation. The results of the use of Ganga system in this particular role have been optimal in terms of submission reliability and robustness: a negligible failure rate in submission operations has been registered in a multi-submitter environment.

Bookkeeping metadata are integrated with Grid Logging & Bookkeeping service (LB) information provided by the infrastructure. In addition, the submission mechanism takes into
Figure 2. Structure of simulation in production cycles, requests and submissions. The WebUI follows the same structure in turn.

account sites availability data from Nagios monitoring service. Simulation jobs are also exposed to the Grid dashboard for monitoring.

5. Web Portal
The WebUI provides separate management for Fast simulation and Full simulation productions. Both sections are divided in configuration, submission and a monitor subsections. Their content is dynamically generated from the bookkeeping database schema and state in order to include the simulation-specific fields.

A production cycle consists of several requests (defined by a specific set of job parameters values and events), which in turn are divided in several submissions, each consisting of several jobs, as shown in Fig. 2. A configuration interface for requests definition, per production cycle and simulation type, is provided. Multi-site submissions based on requests and fine grain parametric submission interfaces complete the set of available services permitting a shift based scheduled session and a debugging specific console, respectively.

The Web-interface provides rich monitoring features by means of querying the bookkeeping database and interacting with Logging and Bookkeeping gLite service. The user can retrieve the list of jobs as a function of their unique identifier (or range of them), their specific parameters, the execution site, status, etc. The monitor provides, for each job, the list of output files – if any – and a direct access to the corresponding log files. Reports on output file size, execution time, site loading, job spreading over workflow requirements, and the list of the last finished jobs (successfully or with failures) are also provided.

A basic authentication and authorization layer, based on a LDAP directory service, permits the differentiation of users and grants the access to the corresponding sections of the Web-Interface. In the present implementation, the job-initialization interface provides a set of automatically-generated nested scripts. Portal automatically executes the script which subsequently launches a Ganga session taking care of job submissions.

6. Results and Conclusions
The simulation production system has been successfully used in intense production cycles of both Full- and Fast Simulation. Several tens of billion simulated events have been produced. Average failure rate is about 5%, mainly due to executable errors (0.5%), site misconfigurations (2%), and temporary overloading of data repository (2%).

The peak performance reached 7000 simultaneous jobs with an average of 3500, as reported in Fig. 3.
Figure 3. Number of jobs submitted (orange), running (blue), successfully finished (green) and failed (red) as a function of time during last production cycle.

In a direct test against Dirac [12] submission system, the SuperB non pilot-driven system has shown comparable performances and failure rates with respect to Dirac normal mode, despite its smaller footprint. Dirac filling mode, when applicable to SuperB simulation use case, gives equal or better performances, depending on submission mode and rate of SuperB system.

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