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The ARGO-YBJ data processing and the evolution of the computing model to a GRID approach.

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The ARGO-YBJ experiment is currently in data taking with 42 RPC clusters. This paper describes the processing of the experimental data, based on a computer farm of 38 bi-processors and 10Tbyte of disk space. The software developed for the data management, job submission and information retrieval is described. The evolution of the ARGO computing model towards the integration in the GRID environment is also presented.

1. Introduction

The Chinese-Italian cosmic-ray telescope ARGO-YBJ has been partially installed in Tibet and put in data acquisition with 42 clusters at the end of 2004. It is based on a single layer of RPC chambers, organized in groups of 12 (cluster) for data acquisition, and when completed will be composed by 1848 chambers (with 18480 pads) plus an external ring made by 240 chambers. The trigger is based on pad multiplicity. The detector is optimized for small air showers detection for studies in gamma astronomy, gamma-ray bursts, the Anti-p/p ratio, the primary proton spectrum, etc. One of the goal of the present data taking is the debugging of the apparatus, of the DAQ system and of the software developed for data reconstruction, data manipulation and archiving.

2. Computing Model and Real Data

The computing model was based on simulated data and is summarized in Table.1 where two major data taking phases are presented. The reported numbers, used mainly for reference and rough dimentioning of the computing farm, are based on simplified assumptions : 80% of duty cycle, 250 bytes raw event size , low trigger threshold, 50 bytes reconstructed event size, reconstruction time per event around 20ms using 1GHz PIII CPU, equivalent to 420 SPECint2000 and one full re-processing cycle/year.

Table 1. Project data rates and processing requests for 42 and 154 clusters

Trigger Rates (KHz)	Events/year	Raw data TByte/year	SPECint2000
5.2	1.2×10^{11}	28	38000
25.	6.2×10^{11}	200	166000

This scenario was modified during this initial phase due to many reprocessings, with different reconstruction algorithm and due to the addition of the data quality check , with its own output files. The debugging character of this phase explains the numbers here reported. The 91 days of data taking corresponded to a period of DAQ activity of 47.3 days with 1913 RUNs. The data were collected in one GBytes files (up to 16 files/RUN). The trigger used by the DAQ (60 hits) allowed the the collection of 2.9 TByte of data with 240 millions of events (1 Kbyte/event). The average reconstruction time/ event, when using the planar fit algorithm, is around 0.06 sec on a 800 MHz PIII CPU, i.e.3 times longer than previewed,. This t seems reasonable because of the data quality algorithm added to the reconstruction and to the saving of the raw data in the ROOT persistent format. The reconstruction of the events with a conical fit requested around 0.03 sec/event when using a 2.4 GHz Xeon CPU and the raw input data was in the persistent ROOT format, and the data quality check was excluded.

3. Processing Farm Layout and Organization

The storage elements, the computing elements and their interconnection are described in the Figure1. They are all running 7.3.2 RedHat Linux, with an upgrade to Scientific Linux at the end of this processing period.

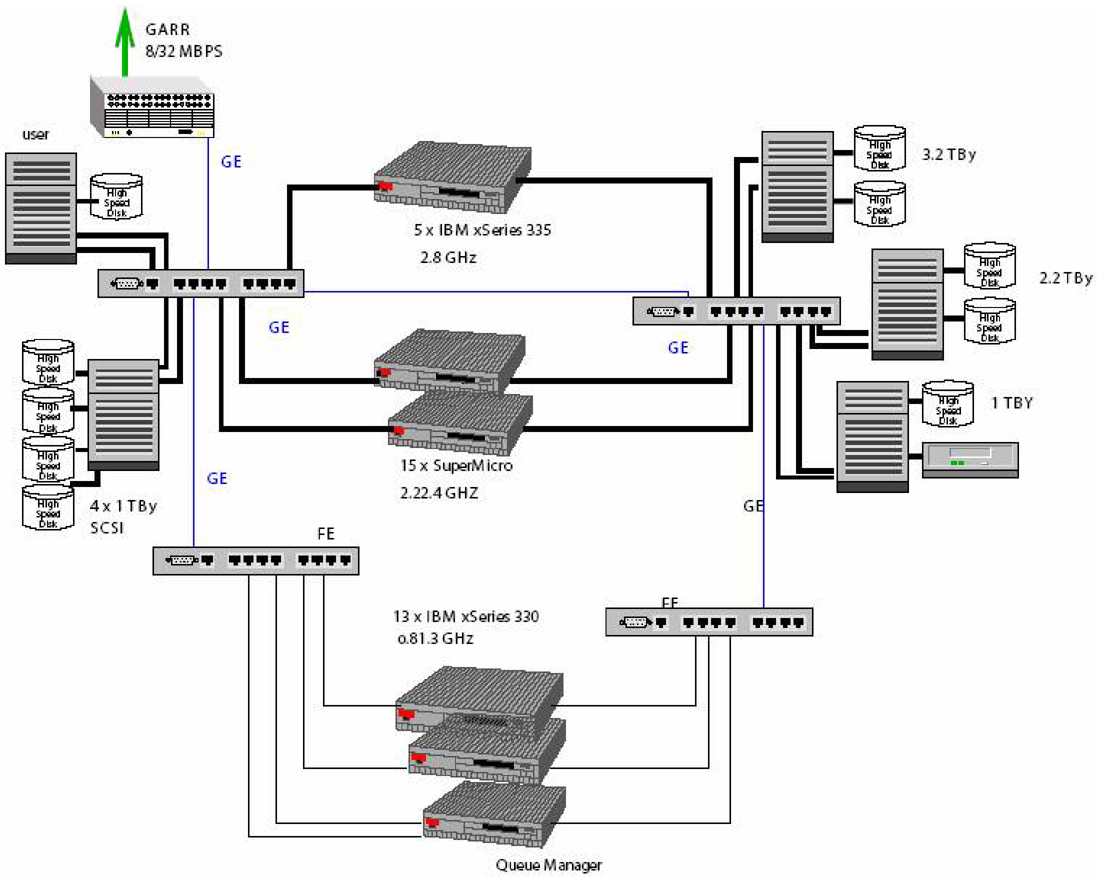

Figure 1. ARGO-YBJ Processing Farm Organization and Layout

The overall computing power (38 bi-processors from 800 MHz to 2.8 GHz) – cca 50 KSI2000 – proved to be sufficient for this initial phase of multi data processing cycles, as well as the storage capacity (10 TByte RAID5 of disk space). The computers are interconnected via GE and FE switches, each computing element being connected with one Ethernet interface on a switch and one on the other, so that the input and the output data traffic are separated for performance reason. The farm use a DLT loader and a LTO robot for raw data input. The experimental data are also sent via network (8MBPS link, upgradable in the future) from YBJ to Beijing and work is underway to build a "splitter" in Beijing that sends a copy of the data via network to IHEP in Beijing and another to the Rome III farm .

4. Data Manipulation and Archiving System

The data submission is based on GRIDWARE software, vers. 6.0u1 (SunOne GridEngine), a complex queueing and submission system done by GRIDWARE Inc., now distributed by SUN. The system proved to be very reliable and efficient. We tested up to 60 Kjobs being manipulated and resubmitted correctly in emergency situations.
The data processing is organized in more phases and realized via a number of quite complex PERL scripts, and PHP scripts for GUI interfaces. Once the data arrive on the disks the first phase scripts analyze the correctness of each RUN (i.e. the presence of all the data, log and slow control files belonging to that RUN) and the info are introduced into a work DB (EMS POSTGRESQL v.7.4) . A second phase take the relevant information (looking also inside the slow control and log files) and introduce them into the Production DB (see Figure2)

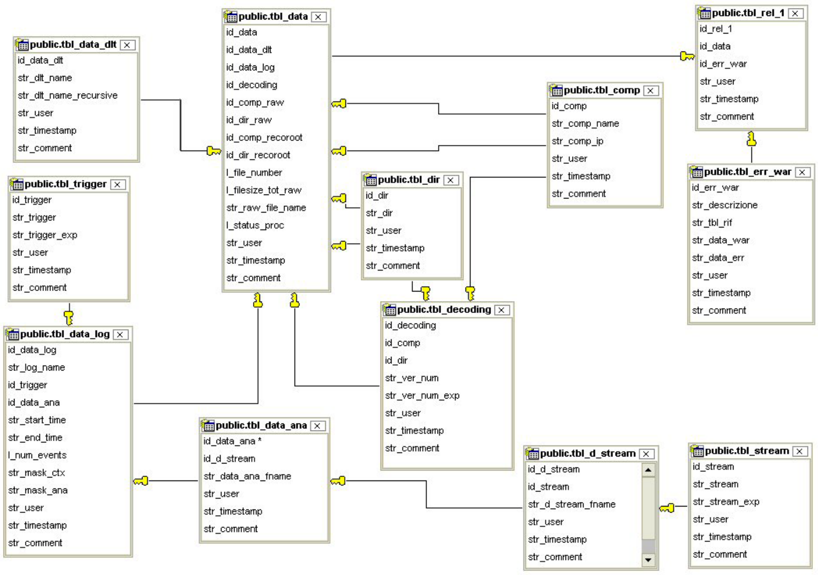

Figure 2. Production DB organization

The information saved in this phase are : RUN name, RUN start and stop time, the trigger used, no. of files in the RUN and a mask of presence of all the files and of all the slow control and log files, the position of the raw data inside the farm , the DLT number. The 3rd phase interrogates the DB and extracts the RUNs to be processed, builds the submission scripts to GRIDWARE system, the reconstruction configuration files for each RUN and the list of data files for each RUN. The 4th phase submit the jobs, upgrading a processing flag in the DB. When the jobs finish, the status flag is updated and other information are saved in the DB (position of the output, program version, quality parameters) . The DB foresees other info for future physics analysis developments. A GUI interface was developed to ease data access and manipulation.

5. Next Developments and Computing Model

In the near future the experiment will enhance the DAQ system together to the completion of the carpet installation, and a new format of the data, with data reduction, will be introduced, reducing the event size from 1 Kbyte back to the project value (250 byte). The processing farm for this new set of experimental data will be at CNAF, INFN main computing center. This center operates already in GRID environment and the migration of the ARGO manipulation and archiving system to CNAF will be done together to the introduction of a new computing model for ARGO, that will be based on GRID approach, with its own Virtual Organization. The CNAF will become the center where the raw data will arrive from Tibet, via network, and will be processed. The Roma III farm will migrate in GRID environment and will be dedicated to physics analysis , and other ARGO analysis farms will join ARGO GRID organization in Napoli and Lecce. The ARGO MC production is already using the CNAF farm.

6. Conclusions

The migration of ARGO software in GRID give us the possibility to build a Chinese-Italian ARGO GRID Virtual Organization , unifying the resources, the procedures for data manipulation and archiving and naturally backuping all the data. This new developments will be done inside the frame of an european project, called EUChinaGRID- Interconnection and Interoperabilityof Grids between Europe and China, submitted to the EC this spring (and now in final negotiation phase) and aiming to promote the GRID interconnection between EC and China. ARGO is one of the main test application for EUChinaGRID project

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