INTRODUCTION

Since 2001 LNL has been hosting a computing farm which is part of the large grid infrastructure developed to satisfy the computing needs of the modern physics experiments. The farm has been active in the past years as a resource center within the LHC Computing Grid [1] and the European Grid Initiative [2] projects, participating to the computing activities of all the LHC experiments and especially CMS and Alice. The computing model of these experiments [3] is based on the concept of geographically distributed computing sites organized in a hierarchical architecture of "Tiers". Tier-0 is at CERN and is the largest site, responsible for the data taking and custody and for the first processing of the event reconstruction. Copies of the data are then sent to several Tier-1 sites which will host a second custodial copy and will run further data re-processing with improved calibration. The results of these steps are the data meant for end-user analysis, which, appropriately organized in datasets, are transferred to the many Tier-2 sites around the world. These provide the storage and computing resources for the analysis. Besides the analysis, the other important task assigned to the Tier-2 centers is the production of MonteCarlo simulated events, which should take up about 50% of the computing resources. The LNL center has been an official Tier-2 site for CMS since 2006.

2010 RESOURCES

As in the previous years, also in 2010 the hardware resources of the center continued to increase, with new acquisitions for both experiments. The total amount of resources at the end of 2010 is summarized in table 1.

Table 1. Computing and storage resources available at the end of 2010.

<table>
<thead>
<tr>
<th></th>
<th>CPU [kSI2000]</th>
<th>Disk [TB]</th>
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<tbody>
<tr>
<td>CMS</td>
<td>2000</td>
<td>500</td>
</tr>
<tr>
<td>ALICE</td>
<td>630</td>
<td>140</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2630</td>
<td>640</td>
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The increase has been especially notable for the storage, almost doubled from the previous year, in anticipation of the large demand for 2010, which has been the first year of full running for CMS and the other LHC experiments.

And indeed, despite the still low value of LHC luminosity, during 2010 there has been a significant increase in computing activity, as can be seen in figure 1, which represents the cumulative amount of CMS data transferred to Legnaro, for a total of almost 500TB.

These data are both real events taken by the experiment and MonteCarlo samples produced over the distributed computing infrastructure and transferred to the Tier-2 sites where all the analysis jobs are run by the users.

Fig. 1. Cumulative amount of CMS data transferred to Legnaro during 2010.

Fig. 2. Distribution among the experiments of all 2010 jobs run at LNL Tier-2.

The distribution of all 2010 jobs among the experiments is represented in figure 2. The main users are obviously CMS and Alice, with a share roughly proportional to their...
respective share of resources, but there is still some room for other experiments to use a fraction of the available computing power.

SERVER VIRTUALIZATION

One of the problems in the management of a Tier-2 has been the constant increase in the number of different services that a site has to setup and maintain. Starting with the basic Grid services present from the beginning (Storage and Computing Elements, Grid Information System, User Interface and few others), over the past years there has been a continuous addition of new services required by the experiments for their specific needs, like, for instance, data transfer book-keeping, custom job monitoring, local databases, software cache, etc. Usually each service requires to be run on its own specific machine because it is difficult to install and maintain different services on the same server, due to very specific and often conflicting software dependencies. This led over the years to a proliferation of servers often under-used as compared with the respective computing power and thus to a significant inefficiency in the use of the resources and larger costs of management and maintenance for all these critical machines.

To deal with this problem, from the end of 2009 we have started to adopt the solution of "server virtualization", where a physical machine, equipped with the proper software, can run several virtualized independent servers. Through the virtualization software it is also possible to dynamically assign the available memory and CPU to the different virtual servers, thus allowing a much more efficient use of the resources. The downside is that the performance of a virtual server is usually lower than a real one and so this kind of solution is not always viable for all services, in particular for those requiring a high level of network or disk traffic.

There are several virtualization softwares available and after an initial period of experimentation with XEN [3] and VMware [4] we chose this last one to start virtualizing some production services. After the good results obtained with these first tests, both in terms of reliability and good performance, over the following months we proceeded to gradually extend this solution to more and more services. As at the end of 2010, we have 3 virtualization servers, all with VMware version ESXi 4.0, running a total of 14 virtual servers.

One of the weak points of our current virtualization infrastructure is that each server has its own local disks, so that it is not possible to move a virtual machine to a different server without shutting down the machine and stopping the service. For the future we plan to setup a common storage system, shared by all of the virtualization servers, which would allow the dynamic move of virtual machines among the servers, thus providing a greater reliability because in case of a hardware failure the virtual machines can be automatically moved to another server.

CMS USER INTERFACES

Since the beginning, the Tier-2 center has been a project carried out in collaboration between LNL and INFN-Padova, but for many years the hardware and the manpower for the center management has been located only at Legnaro. Back in 2009 we started a process of closer integration with Padova, with the aim of creating a computing center distributed between the two sites [6]. In 2010 we took further steps in this direction, with additional hardware installed in Padova and also with the integration in Tier-2 of the Padova CMS analysis farm. This consists of a number of servers and disks where CMS users can run the small local analysis and submit their larger jobs to the Grid. The old storage, scattered on many different disks, has been partly replaced by a new disk-server and then completely reorganized in a distributed file-system of 20 TB based on Lustre [7]. The computing power is now provided by four new 24-core machines, all installed as standard Tier-2 User Interfaces, thus making the CMS and Grid software always available in the latest releases. This new setup reduces the efforts required for the maintenance of the old farm and provides the users with efficient and easier means to use analysis resource.