Distributed Russian Tier-2 – RDIG in Simulation and Analysis of Alice Data From LHC.

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Abstract. On the threshold of LHC data there were intensive test and upgrade of GRID application software for all LHC experiments at the top of the modern LCG middleware (gLite). The update of such software for ALICE experiment at LHC, AliEn[1] had provided stable and secure operation of sites developing LHC data. The activity of Russian RDIG (Russian Data Intensive GRID) computer federation which is the distributed Tier-2 centre are devoted to simulation and analysis of LHC data in accordance with the ALICE computing model [2]. Eight sites of this federation interesting in ALICE activity upgrade their middle ware in accordance with requirements of ALICE computing what ensured success of MC production and end-user analysis activity at all eight sites. The result of occupancy and efficiency of each site in the time of LHC operation will be presented in the report. The outline the results of CPU and disk space usage at RDIG sites for the data simulation and analysis of first LHC data from the exposition of ALICE detector [3] will be presented as well. There will be presented also the information about usage of parallel analysis facility based on PROOF [4].

Introduction
In the period of steady LHC operation there is permanent and high usage of GRID in the massive RAW processing and MC production. There is also quiet successful usage of GRID in the end user analysis. The positive results of GRID usage could be owed to many applications developed in the early years at ALICE Grid environment. ALICE has made an effort to consolidate all of these applications in a coherent set of monitoring and control tools. The intensive usage of distributed Tier-2 – RDIG computing resources with a stable operation of its has been realized means of this control and monitoring tools application also. What improvements of ALICE workload have been achieved in the preparation time before the first LHC data?
First of all from the side of middleware development:
1. Migration of middleware services and working nodes to 64 bit versions of gLite3.2[5], tuned under SL5
2. New features of VO ((Virtual Organization) boxes under support of gLite3.2[6]
3. Migration from LCG-CE[7] to CREAM-CE[8]
Improvement and new features developed by AliEn;
1. Automatic storage elements discovery
2. Update of data management under xrootd[9],
3. Workload management based at Job Agent(JA) schema
4. Implementation of job and file quotas for end-user analysis.

Results of RDIG – Tier2 operation will be shown in this report at the example of MC simulation and analysis data from detector exposition in pp beams of LHC.

1. Structure and management of ALICE RDIG computing
RDIG – distributed Tier2 is presented in ALICE computing by 8 computing centers, sites: site IHEP from Institute for High Energy Physics in Protvino near Moscow, site ITEP from Institute for Theoretical and Experimental Physics in Moscow, site JINR from Joint Institute for Nuclear Research in Dubna near Moscow, site MEPhI from Moscow Engineering Physics Institute in Moscow, site PNPI from Petersburg Nuclear Physics Institute in Gatchina near Saint-Petersburg, site RRC-KI from Russian Research Centre “Kurchatov Institute” in Moscow, site SPbSU from Saint-Petersburg State University in Saint-Petersburg and site Troitsk from Institute for Nuclear Research in Troitsk near Moscow. Control for the successful operation of these eight sites was managed by system administrators of sites, the representative of ALICE computing in Russia from JINR and technical coordinator from SPbSU. Aggregate resources of these sites pledged by Russia and JINR in 2010 have composed 23% of whole number of RDIG CPUs and 816 TB of RDIG disk space.

The status of GRID services in time of LHC data development and analysis at RDIG sites has to be adequate to these tasks. What we had in that time:
   a) All 8 sites are processing ALICE jobs under CREAM-CE only, from beginning of 2010.
   b) All these sites have been updated to the last AliEn version – 2.18.
   c) RDIG ALICE Federation managed of SE under last xrootd version.

2. CPU availability
Let us consider how these resources have been used in time of LHC operation.
At the figure 1 there one can see the share of CPU resources of RDIG between four LHC experiments during collider operation.

![Figure 1. RDIG CPU usage by four LHC experiments from April to November of 2010: ALICE (40%), ATLAS (22%), CMS (28%), LHCb (10%).](image)

It is seen that ALICE have used at the time of first LHC operation more RDIG CPU (40%) than it has been pledged in 2010 (28%).
3. DISK space availability
How intensively has been used the disk space data in the same time? Data of the disk space is presented in figure 2 as MonaLisa[10] page of ALICE monitoring and table 1 for SE of RDIG sites updated in the December 2010.

| Site          | Disk (TB) | Pledged | Alloc. | Used  |
|---------------|-----------|---------|--------|-------|
| IHEP          | 36        | 36.38   | 6.635  |
| ITEP          | 60        | 59.97   | 29.55  |
| JINR          | 271       | 149.1   | 40.75  |
| MEPhI         | 24.5      | 18.19   | 17.18  |
| PNPI          | 39.9      | 39.95   | 10.96  |
| RRC-KI        | 257.5     | 202.6   | 69.15  |
| SPbSU         | 62.6      | 61.71   | 5.177  |
| Troitsk       | 67        | 67.21   | 20.65  |
| **Total**     | **818.5** | **635.1** | **200.052** |

Figure 2 The example of ALICE SE MonaLisa page in time of LHC operation.

Table 1 Disk resources for ALICE at RDIG in 2010 (updated in December).

In the time from January till October of 2010 there were used 1209997.4 kSi2k of RDIG CPU by ALICE for the simulation and analysis of LHC data. 472 TB of RDIG disk space have been available in the same time.

4. Network Operation
The network operation in LHC run is presented in figure 3(input traffic) and figure 4(output traffic).

Figure 3 Input traffic of RDIG sites in 6 months of LHC operation

Figure 4 Output traffic of RDIG sites in 6 months of LHC operation

Summary traffic of RDIG sites during input operation achieved 613.4 GB; output summary traffic was equal 41.03 TB.

5. Event Processing
It is interesting to understand what number of processing events has been contributed by RDIG sites to whole statistics of ALICE. This information could be extracted from data presented in figure 5.

Figure 5 ALICE Report of computing usage in 6 months of first LHC operation

These data are data of different ALICE national federation contribution to processing and done events developed, simulated and analyzed by whole ALICE. It is seen from these data that 1128162 from 12988113 (8.7%) events have processing and 744895 from 7566281 (9.8%) events have been done successfully by RDIG sites, only.

The share of these events from April to October between different RDIG sites is presented in figure 6 and percentage contribution of these sites one can find in figure 7. There is shown in these figures the different RDIG sites contribution from CREAM CE as well from LCG CE.

6. Data Analysing

It is interesting to understand what part of total running jobs has been analyzed at RDIG sites? The answer to this question can be found with help of data presented at figures 8 and figure 9.
The contribution of all analyzed DONE jobs to all DONE jobs by whole ALICE is equal 5251232/8620577 = 61%. So from successfully completed 744895 events at RDIG sites there have been not less than 450000 events of analyzed jobs. Not less than 250 users of ALICE were analyzing data ay RDIG sites, including users from Russia and Joint Institute for Nuclear Research. There have been considered above the analysis done in batch. The usage of PROOF facility let ALICE users to do analysis interactively. And this facility was and is using extensively in ALICE for the data analysis.

7. PROOF

The new type ALICE Analysis Facilities, called AAF is a distributed PROOF cluster used for interactive parallel data processing. There is combined ROOT’s package PROOF, with settings XROOTD (ALICE SE), which is responsible for working with data, where the Packman ensure the timeliness software across a cluster. This new type of PROOF cluster was setup at JINR in Dubna and is called JRAF (JINR Russia Analysis Facilities), see Table 2. Figure 10 presented aggregated network traffic at this PROOF cluster.

In order to analyze data, it is necessary to have the data on the storage space PROOF cluster. In the case of AAF is storage directly to a local drive of each computer in the cluster. It was necessary to ensure copy data from Alien to the cluster catalog. To accomplish this task it was necessary to create so-called dataset, which is basically a list of files. Data are divided into two groups:

a) official (real data, data from Monte-Carlo simulation),

b) user datasets (datasets created by users).

Table 2: List of PROOF clusters at Alice Analyzed Facility (AAF)
Conclusion

1. All RDIG sites were and are supporting modern middle and application softwares required by ALICE.
2. Contribution of Russia and JINR sites into computing resources delivered for ALICE as well the number of simulating and analysis events is proportion to the M&O number of this Federation authors.

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