Organization and Support of LHC Computing at the Joint Institute for Nuclear Research

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1 Introduction

The activities on the LHC computing support will become especially important before the LHC start, which is expected in the year 2008. During more than a decade, the Joint Institute for Nuclear Research has participated in the implementation of the facilities required by three experiments to be done at the Large Hadron Collider – ALICE, ATLAS and CMS. From now on, it is necessary to provide proper computing support in the JINR for the JINR scientists participating in these experiments. A distributed grid computing infrastructure adopted for the LHC experiments has been successfully built as the RuTier2 (Russian Tier2) distributed cluster. This has undergone a long time testing at Russian institutes and JINR, which are members of the Russian Data Intensive Grid (RDIG) consortium. In accordance with RDIG computing model for the LHC computing, a distributed RuTier2 cluster operates sharing the resources located at different institutes between all the LHC experiments. Consequently, the JINR-LCG2 farm works in this operation mode also.

2 JINR-LCG2 computing farm

In 2006-2007, the JINR-LCG2 computing farm and dCache storage system have been significantly modernized and extended. By now, there are 251 CPU (240 at the Laboratory of Information Technologies (LIT) and 11 at the Dzhelepov Laboratory of Nuclear Problems) and 40 TB at the Storage Element in the JINR-LCG2 configuration. These resources are in active use by ALICE, ATLAS, CMS and LHCb (see Table 1) in a grid environment.

*	Jun 07	Jul 07	Aug 07	Sep 07	Oct 07	Nov 07	Total
alice	6643	7411	18424	12172	6177	1143	**51970**
atlas	2320	4715	1198	1714	1450	194	**11591**
cms	2303	2930	4748	2683	15863	3672	**32199**
lhcb	6386	924	679	1847	185	130	**10151**
Total	**17652**	**15980**	**25049**	**18416**	**23675**	**5139**	**105911**

Table 1: Number of jobs executed at the JINR-LCG2 computing farm by users of the ALICE, ATLAS, CMS and LHCb virtual organizations during June-November, 2007

ALICE, ATLAS and CMS users can also work at the JINR Central Information and Computing Complex (CICC) as local users (not using grid tools): debugging jobs, submitting them to the local batch system with the usage of the appropriate specialized software installed locally at the AFS system.

Large volumes of data are stored at the dCache system providing both local and global access to the data [1].

One of the main tasks of the LHC computing support is to fulfil the collaboration requirements conserning the:

- software environment,
- storage system configuration,
- external communications (network bandwidth and reliability of data transfers).

2.1 Software

In 2007, the migration to the 64-bit architecture under Scientific Linux 4 operating system has been accomplished at the CICC. The following current versions of the specialized software are installed at the JINR-LCG2 site:

- **for ALICE -** AliEn (v2-13.141), VO_ALICE.AliRoot.v4-06-Rev-04, VO_ALICE.APISCONFIG.V2.2, VO_ALICE.GEANT3.v1-8-1, VO_ALICE.loadgenerator. v-1.0, VO_ALICE.ROOT.v5-16-00;
- **for ATLAS -** VO-atlas-cloud-NL, VO-atlas-production(12.0.31, 12.0.5, 12.0.6, 13.0.20, 13.0.30 and 13.0.30.1), VO-atlas-release(11.0.42 and 11.0.5), VO-atlas-tier-T3;
- **for CMS -** VO-cms-CMSSW(1_6_0, 1_6_1 and 1_6_3 - 1_6_7);
- **for LHCb -** VO-lhcb-Gauss(v25r9 - v25r12), VO-lhcb-XmlDDDB(v22r2 and 30r14), VO-lhcb-Boole-v12r10, VO-lhcb-DaVinci(v17r6 - v17r8, v18r0 and v19r0 - v19r5), VO-lhcb-Brunel(v30r15 and v30r17), VO-lhcb- DecFiles(v13r9, v13r10 and v13r12), VO-lhcb-ParamFiles(v5r0).

Several versions of ALICE, ATLAS and CMS software are being also installed at the CICC locally at the AFS system.

2.2 Storage System

The dCache system was chosen instead of the Castor system to store large data volumes since it responds the best to the requirements of the JINR as a Tier2 center in the WLCG (Worldwide LHC Computing Grid) hierarchy. The technical details on the dCache system at the JINR CICC are presented in [1].

2.3 Network bandwidth and reliability of data transfers

The following LHC computing centers serve as Tier1 centers for RDIG: FZK (Karlsruhe) – for ALICE, SARA (Amsterdam) – for ATLAS, CERN – for CMS (CERN-PROD) and LHCb. The quality of the JINR – Tier1s connectivity is under close monitoring [1].

3 ALICE support at JINR-LCG2

Regular update and testing of the ALICE software (AliEn) required for ALICE production Data and Service Challenges and distributed analysis were implemented by the LIT JINR specialists not only at the JINR-LCG2 site, but at all RDIG sites [2]. A special gLite service, called VOBOX, plays a key role in the ALICE computing model for interactions between ALICE central services and grid sites. VOBOX for ALICE is installed and supported at the JINR-LCG2 site. AliEn services are installed at the VOBOX, and VOBOX also provides access to the dedicated experiment software area to install ALICE-specific software (it is done automatically by a special AliEn service – the package manager) which is shared among the working nodes of the site. AliEn is managed (i.e., it is installed, configured and run) by a special user named ALICE software group manager (alicesgm). AliEn consists of the following components and services: authentication, authorization and auditing services; workload and data management systems; file and metadata catalogues; package manager; information service; Grid and job monitoring services; storage and computing elements. The Grid monitoring via MonALISA is a very important part of ALICE application software [3]. Almost complete monitoring and running history on the ALICE Grid are available [4].

The gLite component File Transfer Service (FTS) [5] is used for ALICE data transfers between T0 and T1s. All other scheduled transfers are done through the File Transfer Daemon

(FTD) with xrootd [6] as a transport protocol. ALICE uses two tools for transfer monitoring: Gridview [7] which provides a high level view of all the network traffic and MonALISA repository [8] where only successful transfers are shown. The following data rates between Tier0-Tier1 have been reached: 1-hour average rate: 220MB/sec, 1-day average rate: 130MB/sec. Early FTS transfers tests between JINR and its Tier1 (FZK) were done in July – August 2007.

4 ATLAS support at JINR-LCG2

In frames of cooperation between the LIT and the ATLAS collaboration, a dedicated Computing Element (CE) was installed at the JINR-LCG2 site (lgdce01.jinr.ru) enabling a special short queue (CPU time per job less than 1.5 hour) for any ATLAS VO (Virtual Organization) user. It provides the possibility for submittals of short analysis jobs which require a quick response, with waiting times not exceeding 10-20 minutes. Also the local CICC computing infrastructure was made ready for a full-scale simulation of Higgs boson decay ($H \rightarrow 4\ \mu$ carried out by the JINR ATLAS team [9]). For this purpose, proper versions of ATLAS software were installed at the AFS system of the CICC, access to ATLAS CVS (authentication with the Kerberos usage) and sufficient storage resources (required for storing Monte-Carlo, Digi, ESD and AOD data and analysis ntuples) were provided.

5 CMS support at JINR-LCG2

During 2006-2007, JINR participated in all the computing challenges (large scale testing of the global CMS computing infrastructure) conducted by the CMS collaboration. In autumn 2006 during CMS event simulation 500 000 events were produced at JINR (1% of total events produced by CMS). The 8% CMS user analysis jobs, submitted by CMS automatic Job Robot system to all CMS sites were successfully executed at JINR. CMS Magnet and Cosmic Challenge (MTCC) with a large volume of data (about 850 GB/day) was held at CERN in 2006. Part of these data was transferred to JINR with the usage of grid tools for further physical analysis. It was a very good opportunity to test the data transferred from CERN to JINR.

The PhEDEx data transfer system is a specific system used in the CMS collaboration for data transfer between the CMS LCG sites. PhEDEx server for the RDIG CMS centers is located at the CMS VOBOX installed and supported at the JINR-LCG2 site. During 2006-2007, the quality of CERN-JINR and JINR-CERN connectivity was permanently tested. An example of the PhEDEx testing data transfer is presented an Fig.1. It is seen that this day transfer rate was up to 30 MB/s, and 99% of the test files were transferred successfully. As a result, about 1 TB of test data has been transferred from CERN to JINR during one day.

Due to the problems arising with the CMS system-user mapping to a single user (inconsistency with the policy adopted for the LCG infrastructure when VO system-users are mapped to different users), there were difficulties with installation of the centralized CMS specialized software (CMSW). By now, proper CMSSW versions have been successfully installed and tested by the CMS Job Robot system of automated job submitting (97% of 500 testing jobs simultaneously submitted to the JINR-LCG2 site have completed with the exit code "success"). As a result of complex testing during the year 2007, the JINR-LCG2 site was certificated at the CMS collaboration as fully corresponding to the CMS computing requirements [10].

We also participate in the LCG/ARDA activities on LHC computing infrastructure development, monitoring and user support [11].

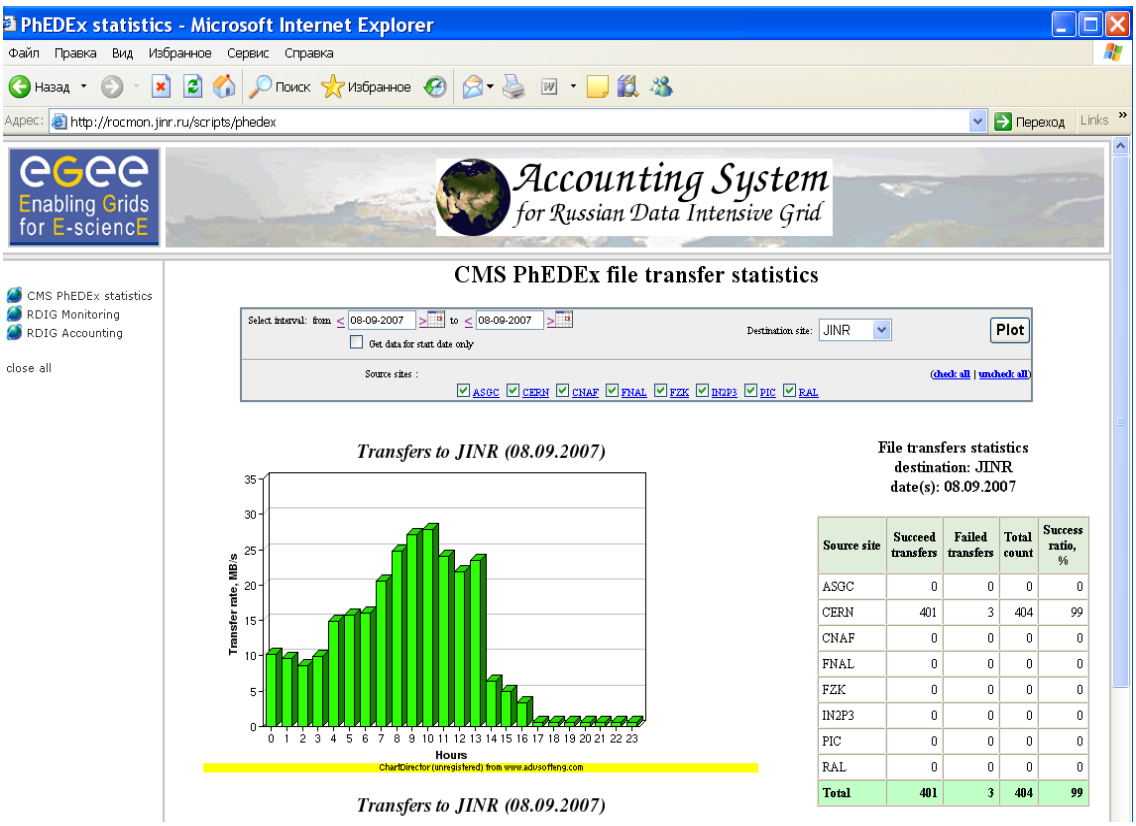

Fig. 1: CMS PhEDEx file transfer statistics web-page at http://rocmon.jinr.ru

6 User training and dissemination

A number of user training courses have been held:

- Courses for LCG administrators and ALICE users from Russian and Ukrainian institutes (February 28- March 3, 2006);
- LCG training for ATLAS users at JINR (May 15-19, 2006);
- Courses on gLite for participants of the international conference "Distributed computing and Grid technologies in science and education" (June 25-30, 2006);
- Courses "CMS user analysis using EGEE/LCG infrastructure" - January 19, 2007;
- Tutorial on distributed analysis of ATLAS data - April 19, 2007.

The JINR specialists coordinate ALICE and CMS [13] computing activities in Russia. They are members of the CERN-Russia Joint Working Group (JWG) on LHC Computing, and regularly present status reports at the JWG meetings at CERN [14]. Status reports on the RDMS (Russia and Dubna Member States) CMS computing were also presented at GRID'2006 conference in Dubna, NEC'2007 symposium in Varna and the conference "Physics at the Future Colliders" in Tbilisi [15].

7 Acknowledgments

The authors thank N.A. Rusakovich, V.A. Bednyakov, A.S. Zhemchugov, and M.M. Shijakova from ATLAS, I.A. Golutvin, A.V. Zarubin, and S.A. Shmatov from CMS, A.S. Vodopianov and G.S. Shabratova from ALICE for fruitful and stimulating discussions, real help and interest.

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