КОМПЬЮТЕРНЫЕ ТЕХНОЛОГИИ В ФИЗИКЕ

STATUS OF RDMS CMS COMPUTING

V. Gavrilov [a], I. Golutvin [b], O. Kodolova [c], V. Korenkov [b],
L. Levchuk [d], S. Shmatov [b], E. Tikhonenko [b, 1], V. Zhiltsov [b]

[a] Institute of Theoretical and Experimental Physics, Moscow

[b] Joint Institute for Nuclear Research, Dubna

[c] Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow

[d] National Science Center "Kharkov Institute of Physics and Technology", Kharkov, Ukraine

The Compact Muon Solenoid (CMS) is a high-performance general-purpose detector at the Large Hadron Collider (LHC) at CERN. More than twenty institutes from Russia and the Joint Institute for Nuclear Research (JINR) are involved in Russia and Dubna Member States (RDMS) CMS Collaboration. A proper computing grid infrastructure has been constructed at the RDMS institutes for the participation in the running phase of the CMS experiment. Current status of RDMS CMS computing and plans of its development for the next LHC start are presented.

PACS: 07.05.-t; 07.05.Bx

INTRODUCTION

Russia and Dubna Member States (RDMS) CMS collaboration was founded in 1994 [1]. The RDMS CMS takes an active part in the Compact Muon Solenoid (CMS) Collaboration [2] at the Large Hadron Collider (LHC) [3] at CERN [4]. RDMS CMS Collaboration joins more than twenty institutes from Russia and the Joint Institute for Nuclear Research (JINR) Member States. RDMS scientists, engineers, and technicians actively participated in design, construction, and commissioning of all CMS sub-detectors in leading areas. RDMS CMS physics program has been developed taking into account the essential role of these sub-detectors for the corresponding physical channels. RDMS scientists made large contribution for preparation of study QCD, Electroweak, Exotics, Heavy Ion and other physics at CMS. The overview of RDMS CMS physics tasks and RDMS CMS computing activities are presented in [5–7]. RDMS CMS computing support should satisfy the LHC data processing and analysis requirements at the running phase of the CMS experiment [8].

---

[1] E-mail: Elena.Tikhonenko@cern.ch

CURRENT RDMS CMS ACTIVITIES

Over the past fifteen years, a proper grid infrastructure for CMS tasks has been created at the RDMS CMS institutes, in particular, at the Institute for High Energy Physics (IHEP) in Protvino, Joint Institute for Nuclear Research (JINR) in Dubna, Institute for Theoretical and Experimental Physics (ITEP) in Moscow, Institute for Nuclear Research (INR) of the Russian Academy of Sciences (RAS) in Moscow, Skobeltsyn Institute for Nuclear Physics of Moscow State University (SINP MSU) in Moscow, Petersburg Nuclear Physics Institute (PNPI) in Gatchina, P. N. Lebedev Physical Institute (LPI) in Moscow, National Research Nuclear University "Moscow Engineering Physics Institute" (MEPhI), National Scientific Center "Kharkov Institute of Physics and Technology" (NSC KIPT) in Kharkov, and National Scientific and Educational Centre of Particle and High Energy Physics of the Belarusian State University (NC PHEP BSU). By the moment, in the CMS global grid infrastructure these RDMS CMS sites operate as CMS centers of the Tier1, Tier2, or Tier3 levels with the following names: T1_RU_JINR, T2_RU_IHEP, T2_RU_INR, T2_RU_ITEP, T2_RU_JINR, T2_RU_PNPI, T2_RU_SINP, T2_RU_RRC_KI, T2_UA_KIPT, T3_BY_NCPHEP, T3_RU_FIAN, and T3_RU_MEPhI [9].

A stable and successful operation of several RDMS CMS Tier2 centers and years of operating experience led to creation the CMS Tier1 center in Russia as an integral part of the central data handling service of the CMS Experiment (CMS Tier1 in Dubna) [10]. The JINR CMS Tier1 center was put in a full-mode operation in February 2015.

In line with the CMS computing requirements for the data-taking phase of the experiment [8], the RDMS CMS grid sites provide:

- the computing and data storage resources in full;
- centralized deployment of actual versions of CMS specialized software (CMSSW);
- data transfers between the CMS grid sites with the usage of the FTS grid service on basis of VOBOX grid services for CMS with the Phedex Server;
- SQUID proxy-servers for the CMS conditions DB access;
- certification of network links at the proper data transfer rates between RDMS CMS and other CMS Tier1 and Tier2 centers;
- daily massive submission of CMS typical jobs by the CMS Hammer Cloud system;
- CMS data replication to the JINR data storage system in accordance with RDMS CMS physicists' requests;
- participation in the CMS Monte Carlo physical events mass production in accordance with the RDMS CMS physicists' scientific program.

As can be seen from the Figure, during October 2014–September 2015 the contribution of RDMS CMS sites into CPU time produced at all CMS sites is at level of 6%. During the same period more than 2 PB of CMS data have been transferred to RDMS CMS sites.

A group of RDMS CMS specialists takes an active part in the CMS Dashboard development (grid monitoring system for the CMS experiments) [11].

The dedicated CMS remote worldwide-distributed centers (ROC) were at JINR, SINP MSU, IHEP, and LPI (FIAN) and provide the following functions: monitoring of CMS detector systems; data monitoring and express analysis; shift operations; coordination of data processing and data management; training and information.

RDMS CMS physicists actively work in the CMS global grid infrastructure, and now we have more than 30 members of CMS Virtual Organization — in particular, 38% of CPU time

Normalized CPU time (HEPSPEC06) per region

CPU time produced at all CMS sites (October 2014-September2015)

produced by the RDMS CMS Grid sites in October 2014–September 2015 was consumed by the RDMS CMS users.

SUMMARY

The main achievement of 2015 is a start-up of the CMS Tier1 center at JINR in full volume and its stable operation.

RDMS sites contribute in the CMS Data Storage, Processing and Analysis Tasks, in particular, they are actively involved into data processing and analysis (as of CMS Physics Groups associated sites) and CMS Regional Operation Centers at JINR/MSU/IHEP/FIAN are operated for remote monitoring of detector systems and data express analysis.

There are still a number of problems (technical, financial, etc.) preventing RDMS Tier2 sites from increasing their resources and operation stability.

REFERENCES

1. *Matveev V., Golutvin I.* Project: Russia and Dubna Member States CMS Collaboration. Study of Fundamental Properties of the Matter in Super High Energy Proton–Proton and Nucleus–Nucleus Interactions at CERN LHC. 1996-085/CMS. 1996; http://rdms-cms.jinr.ru.

2. *CMS Collab.* Technical Proposal. CERN/LHCC. 94-38. 1994; http://cmsinfo.cern.ch.

3. http://public.web.cern.ch/Public/Content/Chapters/AboutCERN/CERNFuture/WhatLHC/WhatLHC-en.html

4. http://www.cern.ch

5. *Gavrilov V. et al.* RDMS CMS Computing Model // Proc. of the Intern. Conf. "Distributed Computing and Grid Technologies in Science and Education", Dubna, 2004. P. 240.

6. *Gavrilov V. et al.* RDMS CMS Computing Activities before the LHC Start-Up // Proc. of 3rd Intern. Conf. "Distributed Computing and GRID Technologies in Science and Education", Dubna, 2008. P. 156–159.

7. *Gavrilov V. et al.* RDMS CMS Data Processing and Analysis Workflow // Proc. of XXIII Intern. Symp. on Nuclear Electronics & Computing (NEC'2011), Dubna, 2011. P. 148–153.

8. *CMS Collab.* The Computing Project // Technical Design Report. CERN/LHCC-2005-023. CMS TDR 7. 2005.

9. https://cmsweb.cern.ch/sitedb/prod/sites

10. *Astakhov N. S. et al.* Tier1-Level Computing System of Data Processing for the CMS Experiment at the Large Hardon Collider // Inform. Technol. Comp. Syst. 2013. No. 4. P. 27–36.

11. http://dashboard.cern.ch/cms