

WLCG Tier-2 site in Prague: a little bit of history, current status and future perspectives

Dagmar Adamova¹, Jiri Chudoba², Marek Elias², Lukas Fiala²,
Tomas Kouba², Milos Lokajicek², Jan Svec²

¹ Nuclear Physics Institute, Rez near Prague, Czech Republic

² Institute of Physics AS CR (FZU), Na Slovance 2, Prague, Czech Republic

E-mail: adamova@ujf.cas.cz

Abstract. The High Energy Physics is one of the research areas where the accomplishment of scientific results is inconceivable without a complex distributed computing infrastructure. This includes also the experiments at the Large Hadron Collider (LHC) at CERN where the production and analysis environment is provided by the Worldwide LHC Computing Grid (WLCG). A very important part of this system is represented by sites classified as Tier-2s: they deliver a half of the computing and disk storage capacity of the whole WLCG. In this contribution we present an overview of the Tier-2 site praguec2 in Prague, the largest site in the Czech Republic providing computing and storage services for particle physics experiments. A brief history flashback, current status report and future perspectives of the site will be presented.

1. Introducing WLCG Tier-2 site in Prague

Czech Republic is a member of the Worldwide LHC Computing Grid (WLCG) Collaboration [1] and provides computing and storage services and resources for the LHC experiments ATLAS [2] and ALICE [3]. These capacities are delivered by the Tier-2 site praguec2 [4] at the Institute of Physics (FZU [5]) in Prague.

In addition to ATLAS and ALICE, praguec2 provides computing capacities also to other High Energy Physics (HEP) projects including D0 [6], NOvA [7], STAR [8], astroparticle projects Pierre Auger Observatory (PAO) [9], Cherenkov Telescope Array (CTA) [10] and also to solid state physics.

It has an excellent network connectivity with the collaborating institutions local and worldwide and with other Grid projects, delivered by the Czech Republic National Research and Education Network (NREN) provider CESNET [11] including dedicated 1–10 Gb/s links. The site is also connected to LHCONE [12].

In this contribution, we present a short overview of the history of praguec2, the current status and activities and plans for meeting the demands of the upcoming Run2 and Run3 of the LHC.

2. praguec2 performance during last 10 years

The computer center at FZU officially started operation in 2004 when all hardware resources were installed in a new server room (UPS, air conditioning completed with water cooling in 2010), but was delivering computing services to HEP projects already in 1998. Since 2004,

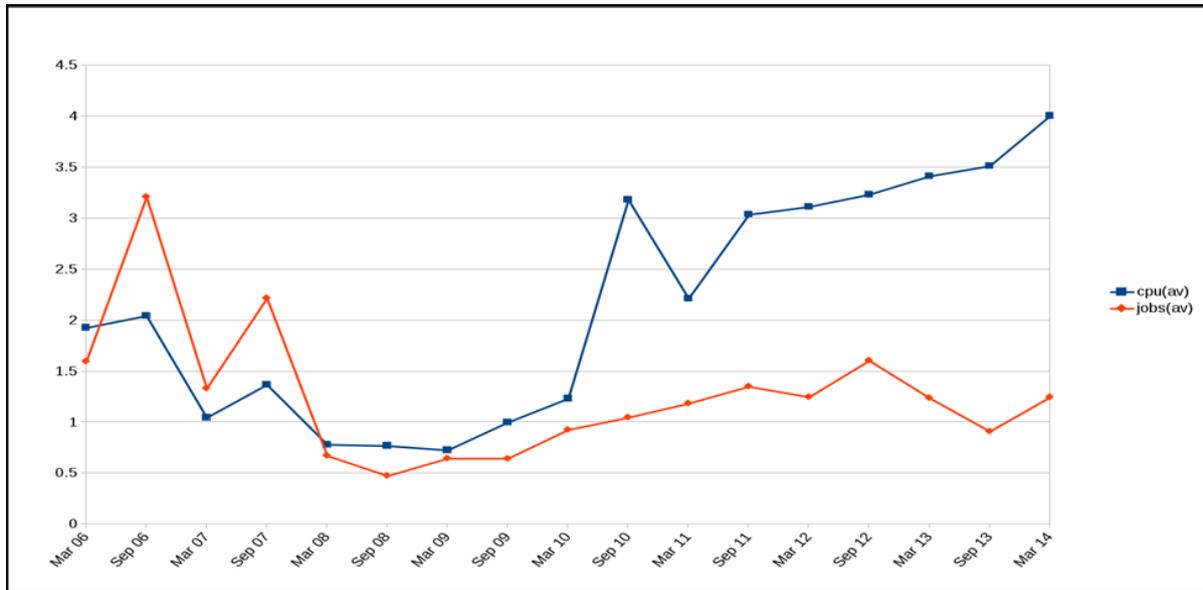


Figure 1. praguecg2 contribution to WLCG Tier-2 computing resources since 2006 (in percents, <http://www.egi.eu/>).

the site operated as a WLCG Tier-2 and participated already in the very first ALICE Data Challenges delivering up to 5 % of the total used resources. The site evolution details till 2009 are presented in [13] and [14]. praguecg2 contribution to WLCG Tier-2 computing resources since 2006 as monitored by EGI [15] is shown in Fig. 1.

Important activities since 2004 include:

- in 2009 some of the first LHC data collected by the ATLAS experiment was processed in praguecg2;
- start of IPv6 [16] implementation in 2011: the site router got an IPv6 address, IPv6 address configuration being done with DHCPv6 and an IPv6 testbed was set up. The first experience with IPv6 deployment on praguecg2 was described in [17];
- an extensive tuning of the XrootD [18] storage cluster dedicated to ALICE in 2011/2012 which increased its performance and fixed the problems with occasional high load on the servers [19];
- since 2008 services management is done by CFengine version 2 [20]. An in-house developed cfagent Nagios sensor [21] enables to automatically fix problems that Nagios detects;
- the site was connected to LHCONE in 2013.

3. Current issues and activities

The current capacity of the site is about 4000 computer cores (CPU) and more than 3 PetaBytes of disk space. The running jobs profile for the last year is shown in Fig. 2. There is a continuous ongoing production of ALICE and ATLAS, the other projects use the site less intensively. The WLCG services provided by the site include: Apel publisher, Argus Authorization service, BDII, several UIs, ALICE VOBOX, Cream CEs and Storage Elements [22]. The use of virtualization [23] at the site is quite extensive.

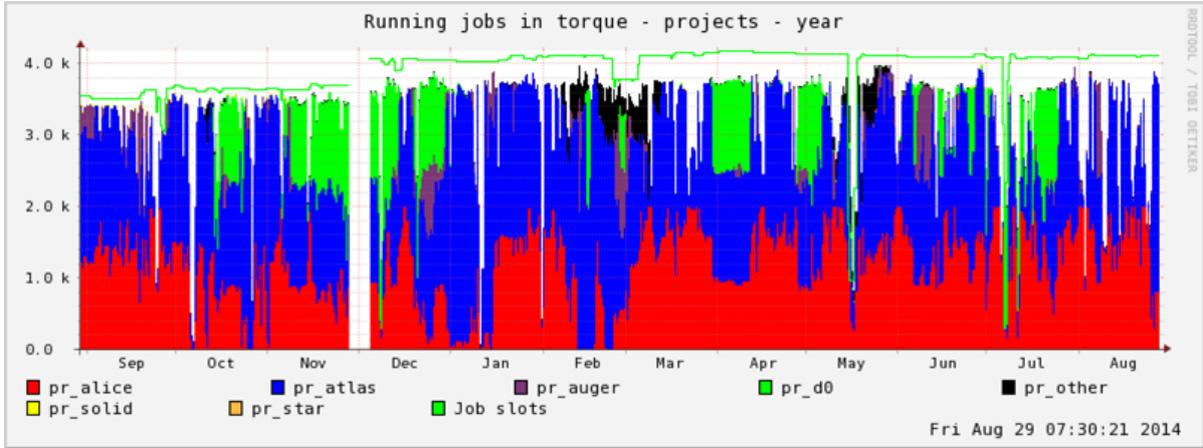


Figure 2. Running jobs profile at praguecg2, 2013/2014.

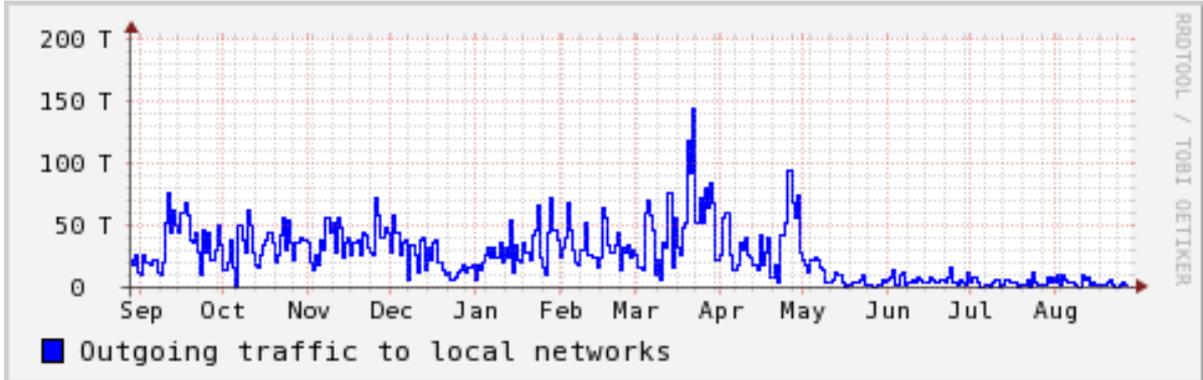


Figure 3. Outgoing IPv4 local traffic from DPM servers (in TeraBytes, monitoring by fzu_site_stat [29]).

As was already mentioned, the external connectivity of the site is provided by the CESNET state-of-the-art infrastructure. An extensive real-time monitoring of the utilization of all included connections can be found in [24].

There has been an intensive ongoing work on deployment of IPv6 on praguecg2 [25]. The site runs an IPv6 testbed and also several production services are already available through both IPv4 and IPv6 including almost all WorkerNodes [22]. In addition, the site is actively involved in the activities of the HEPiX IPv6 working group [26]. Since May 2014 the GridFTP [27] data traffic inside the computing center runs via IPv6. The effect of this transition on the IPv4 and IPv6 traffic from our DPM [28] disk nodes is nicely demonstrated in Figs. 3 and 4.

A massive effort is given to building extensive monitoring of hardware elements and software services on the site. There are five products used on a daily basis: Nagios, Munin, RRD graphs created by local custom scripts, MRTG+Weathermap and Netflow [21]. The monitoring services are gradually migrated to IPv6 operation [25].

Another important issue is a relatively low efficiency of the ALICE jobs processed on the site. ALICE adopted storage solution is XrootD [18] combined with an optional remote data access. Although the jobs preferably process local data it happens quite often that the data must be accessed remotely which can increase the time needed for input/output operations. praguecg2

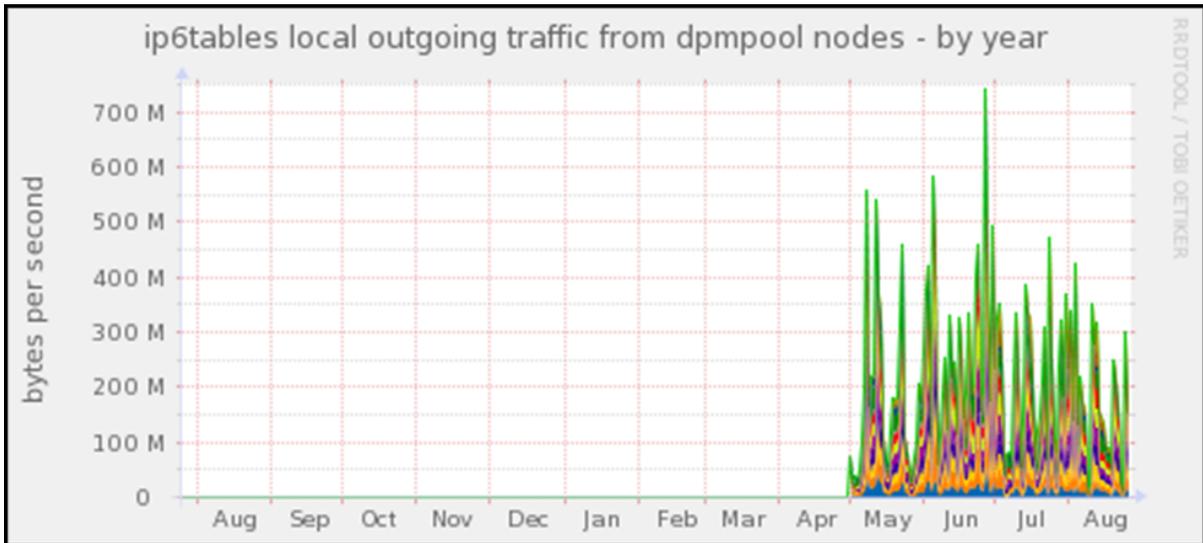


Figure 4. Outgoing IPv6 local traffic from DPM servers (monitoring by MUNIN [30]). Altogether 12 contributing disk servers identified by different colors.

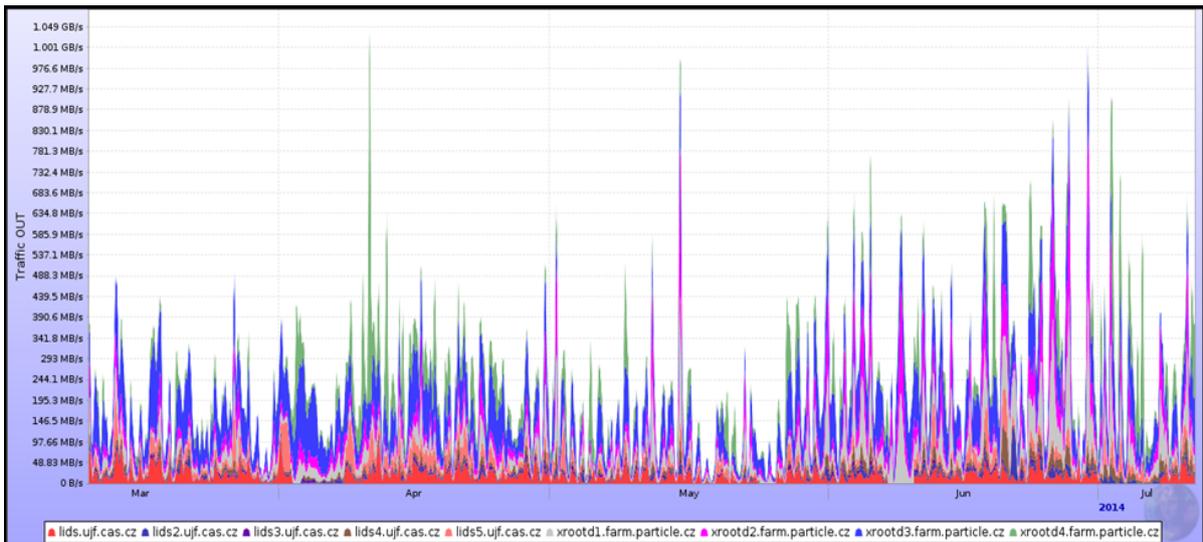


Figure 5. Outgoing network traffic on pragueLcg2 XRootD cluster during 6 months in 2014. Altogether 9 servers, the peak aggregated traffic ~ 1 GByte/s. Almost 2.5 PetaBytes of data were downloaded in total from the cluster.

XrootD cluster is distributed: some of the servers are installed at Nuclear Physics Institute (NPI) about 15 km away from FZU. Although there is a dedicated 10 Gb/s connection and therefore when jobs running at FZU read data from the NPI servers, it is not a genuine remote access, it brings the efficiency down. We are working on identifying the problem with the data access from FZU to the NPI cluster. There again, a proper monitoring is the key issue. The aggregated traffic on our XRootD servers for a 6 months period is shown in Fig. 5.

4. Summary and outlook

praguelcg2 became a recognized Tier-2 site of WLCG providing practically 100 % accessibility, reliable resources and high-level services. Proper conditions have been set up for a full scale participation in the data processing during the LHC running phase. The site team members and collaborators have been actively involved in the study, use and development of advanced Grid technologies.

The upcoming Run2 and Run3 of the LHC will bring orders of magnitude higher particle production which translates into an increase in computing needs: a factor 10–100 is very likely, more is possible. praguelcg2 regularly upgrades its hardware resources on the basis of various financial sources, mainly academic grants. But the upgrade scale happening so far will not be enough for the future LHC demands. In this respect the situation of all WLCG sites is quite alike. Various ongoing activities to find the way to a sufficient resources stack include all kinds of re-engineering and optimization of the HEP software and an endeavor to pool resources between different communities with similar computing interests.

praguelcg2 team members are becoming involved in projects concerning the optimization of Grid software according to their participation in the LHC experiments. Concerning the search for non-HEP resources which might be used for the future processing of the LHC data, we accomplished so far only to get access to an external 35 TB disk storage provided by NGI_CZ [31] and installed about 100 km far from Prague. The storage was used as an opportunity to test the access to external resources [32] but the capacity was too small.

In the coming years, we will do our best to keep up the reliability and performance level of the services and engage fully into the data processing during the next LHC running periods.

4.1. Acknowledgments

This work was supported by the Grant Agency of the Czech Republic (grants No. 202/97/0038, 104/97/S002 and 202/97/P042) and MSMT INGO LG13031 and LG13009.

References

- [1] Worldwide LHC Computing Grid, <http://wlcg.web.cern.ch/>
- [2] A Toroidal LHC ApparatuS, <http://atlas.ch/>
- [3] A Large Ion Collider Experiment, <http://aliceinfo.cern.ch/Public/Welcome.html>
- [4] praguelcg2, <http://gstat2.grid.sinica.edu.tw/gstat/site/praguelcg2/>
- [5] Institute of Physics of the AS CR, <http://www.fzu.cz/en/>
- [6] The DZero Experiment, <http://www-d0.fnal.gov/>
- [7] <http://www-nova.fnal.gov/>
- [8] STAR Experiment, <https://www.star.bnl.gov/>
- [9] Pierre Auger Observatory, <http://www.auger.org/>
- [10] <https://portal.cta-observatory.org/Pages/Home.aspx>
- [11] CESNET, <http://www.cesnet.cz/e-infrastruktura-3/?lang=en>
- [12] HC Open Network Environment, <http://lhcone.net/>
- [13] Lokajicek M et al. 2010 *Prague Tier2 computing centre evolution*, *Proc. of Conf. NEC'2009*, Dubna, p. 8
- [14] Adamova D et al 2010 *Status of the Grid Computing for the ALICE Experiment in the Czech Republic*, *J. Phys.: Conf. Ser.* **219** 072023
- [15] European Grid Infrastructure, <http://www.egi.eu/>
- [16] World IPv6 Launch, <http://www.worldipv6launch.org/>
- [17] Kouba T et al 2012 *IPv6 testing and deployment at Prague Tier-2*, *J. Phys.: Conf. Ser.* **396** 042034
- [18] XRootD project webpage, <http://xrootd.org/>
- [19] Adamova D and Horky J 2012 *An optimization of the ALICE XRootD storage cluster at the Tier-2 site in Czech Republic*, *J. Phys.: Conf. Ser.* **396** 042001
- [20] CFEngine, <http://cfengine.com/learn/manage-processes-and-services-using-cfengine/>
- [21] Chudoba J et al 2013 *JINR (Dubna) and Prague Tier2 Sites: Common experience in the WLCG Grid Infrastructure*, *Physics of Particles and Nuclei Letters* **10** (No.3) pp. 288-294.
- [22] WLCG middleware, <http://wlcg.web.cern.ch/getting-started/software>
European Middleware Initiative, <http://www.eu-emi.eu/>

- [23] virtualization, <http://www.webopedia.com/TERM/V/virtualization.html>
- [24] Large Infrastructure CESNET, <http://netreport.cesnet.cz/netreport/hep-cesnet-experimental-facility2/>
- [25] Kouba T et al 2014 *Enabling IPv6 at FZU - WLCG Tier2 in Prague*, *J. Phys.: Conf. Ser.* **513** 062027
- [26] Campana S et al 2014 *WLCG and IPv6, the HEPiX IPv6 working group*, *J. Phys.: Conf. Ser.* **513** 062026
- [27] GridFTP, <http://toolkit.globus.org/toolkit/docs/latest-stable/gridftp/>
- [28] LCG Disk Pool Manager, <https://twiki.cern.ch/twiki/bin/view/LCG/DpmAdminGuide>
- [29] Eliáš M et al 2011 *Network monitoring in the Tier2 site in Prague*, *J. Phys.: Conf. Ser.* **331** 052024
- [30] MUNIN, <http://munin-monitoring.org/>
- [31] NGI CZ, https://wiki.metacentrum.cz/metawiki/NGI_CZ
- [32] Horky J et al 2013 *Influence of distributing a Tier-2 data storage on physics analysis, 15th Int. Workshop on Advanced Computing and Analysis Techniques in Physics Research (ACAT2013)*, Beijing