



DSA1.3

SET UP OF HARDWARE FOR GRID AND INSTALLATION OF MIDDLEWARE

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Abstract: The BalticGrid infrastructure has been built upon project partner's hardware using grid middleware provided by EGEE project. The infrastructure consists of hardware, e.g. machines for central services, computer clusters and storage servers, and middleware, e.g. software for connecting and virtualizing various computing, data storage and other resources. This document describes the deliverable DSA1.3 "Set up of hardware for grid and installation of middleware." During the first phase of the project the hardware for BalticGrid infrastructure was set up and grid middleware was installed. Appendix I contains the state of BalticGrid infrastructure – hardware specifications and software versions – at the end of 9th project month, August 2006.





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Contents

1. INTRODUCTION.....	4
1.1. ACRONYMS.....	4
1.2. REFERENCES.....	5
2. BALTIC GRID HARDWARE.....	6
2.1. ESTONIA.....	6
2.1.1. <i>History</i>	6
2.1.2. <i>Current situation</i>	6
2.2. LATVIA.....	7
2.2.1. <i>History</i>	7
2.2.2. <i>Current situation</i>	7
2.3. LITHUANIA.....	7
2.3.1. <i>History</i>	7
2.3.2. <i>Current situation</i>	7
2.4. POLAND.....	8
2.4.1. <i>History</i>	8
2.4.2. <i>Current situation</i>	8
2.5. SWEDEN.....	9
2.5.1. <i>History</i>	9
2.5.2. <i>Current situation</i>	9
2.5.3. <i>Current situation</i>	9
2.6. CERN.....	9
2.6.1. <i>History</i>	10
2.6.2. <i>Current situation</i>	10
3. INSTALLATION OF MIDDLEWARE.....	11
4. SUMMARY.....	13
5. APPENDIX I – CATALOGUE OF HARDWARE AVAILABLE FOR BALTIC GRID.....	14



1. INTRODUCTION

The BalticGrid project aims i) to develop and integrate the research and education computing and communication infrastructure of the Baltic States into emerging European Grid Infrastructure, ii) to bring the knowledge in Grid technologies and improve Grids in the Baltic States to a level comparable to that in EU member states with a longer experience in the development, deployment and operation of Grids, and iii) to further engage the Baltic States in policy and standards setting activities. The integration of The Baltic States into the European Grid infrastructure will primarily focus on extending the EGEE to the Baltic States.

The BalticGrid project is of high strategic importance for the Baltic States and it is designed to give a rapid build-up of a Grid infrastructure, enabling the new member states to participate in the European Research Area.

The BalticGrid will take advantage of local existing e-infrastructures, designing and implementing most suitable applications as well as integrating computing infrastructure of academic institutions of the Baltic States.

1.1. ACRONYMS

ARC	Advanced Resource Connector
BDII	Index Information Database
BalticGrid	Baltic Grid Project
BG	BalticGrid
BGCA	Baltic Grid Certification Authority
CA	Certification Authority
CE	Computing Element
CERN	European Organization for Nuclear Research
CMS	Compact Myon Solenoid
CPU	Central Processing Unit
CYFRONET	Academic Computer Centre
DoW	Description of Work
EENet	Estonian Educational and Research Network
EGEE	Enabling Grids for E-science
GÉANT	Multi-gigabit pan-European data communications network for research and education
GOCdb	Grid Operations Centre database
gLite	EGEE Middleware suite
HEP	High Energy Physics
IFJ PAN	Institute of Nuclear Physics of the Polish Academy of Sciences
IMCS UL	Institute of Mathematics and Computer Science, University of Latvia
ITPA	Institute of Theoretical Physics and Astronomy
KTH	Royal Institute of Technology
KTU	Kaunas University of Technology
LCG	LHC Computing Grid



LHC	Large Hadron Collider
NICPB	National Institute of Chemical Physics and Biophysics
PDC	Center for Parallel Computers
PGP	Pretty Good Privacy
PKC	Public Key Cryptography
PKI	Public Key Infrastructure
PoP	Point of Presence
PSNC	Poznan Supercomputing and Networking Center
RA	Registration Authority
RTU	Riga Technical University
SCI	Scalable Coherent Interface
SE	Storage Element
SI2K	SpecINT2000 benchmark
VO	Virtual Organisation
VOMS	Virtual Organisation Management Service
VU MIF	Faculty of Mathematics and Informatics of Vilnius University

1.2. REFERENCES

[1] Baltic Grid Project	http://www.balticgrid.org/
[2] CMS collaboration at NICPB	http://www.nicpb.ee/HEP/
[3] GÉANT network	http://www.geant.net/
[4] GStat monitoring for BalticGrid	http://goc.grid.sinica.edu.tw/gstat/baltic/
[5] NorduGrid ARC middleware	http://www.nordugrid.org/middleware/
[6] Xen virtualization software	http://www.xensource.com/xen/xen/
[7] EGEE Northern Europe Regional Operating Centre (NE ROC)	http://www.egee-ne.org/
[8] LCG Savannah	https://savannah.cern.ch/



2. BALTIC GRID HARDWARE

The BalticGrid infrastructure consists of resources provided and connected by BalticGrid partner organisations, it is based on the previous grid initiatives in Baltic States. Before the BalticGrid project there were several clusters tied together with NorduGrid ARC [5] middleware in Estonia and Lithuania, with over 100 CPUs.

After the BalticGrid project started in November 2005, most of those sites were converted to use EGEE-compatible middleware, namely clusters at EENet, NICPB, VU. The middleware installed at that time was LCG 2.6.

Scientific Linux was installed to front-ends and nodes. In January 2006, there were up and running following sites: EENet, NICPB, VU-MIF-LCG2.

Because it is not possible to install various central services into one machine due to compatibility and performance problems, some nodes from the EENet cluster were used as servers for central services. In April 2006, EENet acquired two Sun x2100 servers solely for BalticGrid central services. Virtualization technology based on Xen [6] is being used for reducing the number of physical servers and for putting various central services into one physical machine.

2.1. ESTONIA

2.1.1. History

Grid activities in Estonia began in the beginning of 2003, when material and bioinformatics scientists from University of Tartu contacted with the Estonian Educational and Research Network (EENet) with idea to form Estonian Grid Initiative. The CMS group from National Institute of Chemical Physics and Biophysics (NICPB) [1] soon joined the initiative. They already had contacts with Nordic Grid initiative. First grid node was set up in NICPB in the beginning of 2004, followed soon by a node in EENet. At that time NorduGrid ARC middleware was used. NICPB did set up the first central services like BDII, CA etc which were later handed over to EENet for continuation and day-to-day operations.

EENet bought some dedicated hardware for use in Estonian Grid, 3-node cluster with total of 6 CPUs, Dolphinics SCI interconnect. NICPB had contributed a 16 node cluster for CMS and Grid related studies.

At the peak time, over 100 CPUs were connected, mostly from computer classes in University of Tartu as well as dedicated clusters from NICPB and EENet.

With the BalticGrid project the middleware was changed and for compatibility reasons with EGEE infrastructure the LCG2 middleware was chosen.

2.1.2. Current situation

EENet has upgraded its cluster to 5-node 10-CPU cluster with Dolphinics SCI interconnect. EENet has added 2TB storage element.

For central services EENet has acquired 2 Sun x2100 machines. On those machines the central services like Broker, BDII, VOMS are running.

NICPB has added an additional cluster of 100 cores and 21TB of storage with plans to upgrade to 150 cores and 80TB of storage in first quarters of 2007. NICPB is actively participating in the CMS experiment with over 100,000 SI2K hours of computing time and around 150TB of data transferred with partners in the CMS collaboration.



The Estonian connection to GÉANT [3] has been upgraded to 1Gbit/s. The connection from GÉANT PoP to Tartu is 1Gbit/s while the connection to NICPB is 2 Gbit/s with average usage around 400-600Mbit/s.

2.2. LATVIA

2.2.1. History

The investigations in parallel computing started in Latvia about 20 years ago in the Soviet time, as the information about first simple multiprocessor soviet computers became available. After the collapse of USSR the researchers that were specialised in numerical simulation or other research activities with need of high performance computing ended their work or joined some groups of researchers abroad, where they could use parallel and supercomputers.

As the result the grid development in Latvia delayed. At the start of Baltic Grid project only a few institutions had their own internal systems for sharing computational resources, so the real history of grid in Latvia started with this project.

2.2.2. Current situation

At this moment real support for grid development by Latvia's government is observed. The money for grid node equipment was allocated, a research project for development of grid in Latvia is supported (2006-2008).

LUMII is currently operating two clusters, one with 9-node/cpu and 1.2TB storage (sitename: IMCSUL), and another with 5-node 20-core, equipped with Infiniband interconnect for high-speed/low-latency data transfers (sitename: IMCSUL-INF). There are separate machines for central grid services.

RTU has joined the BalticGrid project with one 5-node cluster (5 Sun Fire X2100), there are separate server for storage and central services.

2.3. LITHUANIA

2.3.1. History

The development of grid infrastructure in Lithuania began in October 2004 after the first conference on grids – “The First Baltic Grid Conference” – under the initiative of Lithuanian Academy of Sciences. After this conference major universities and research institutes of Lithuania started to discuss grid computing and the usage for the research and studies.

Faculty of mathematics and computer science at Vilnius University and Kaunas University of Technology were most active and soon they installed grid sites using NorduGrid ARC middleware. Computing nodes for grid were installed on virtual machines in students' classes. Under the Baltic Grid Project, NorduGrid ARC was replaced by LCG2 and later by gLite provided by EGEE.

In 2005 national LitGrid project was started.

2.3.2. Current situation

Currently there are 2 clusters at KTU, which are available for BalticGrid users:

- KTU-ELEN-LCG2 – installed on XEN virtual machines at KTU Electronics Design Laboratory students' class, (10 cores);
- KTU-BG-GLITE – cluster, dedicated to Grid (~50 CPUs, not fully working yet).

VU MIF cluster VU-MIF-LCG2 now has 2 entry points:



- grid2.mif.vu.lt – LCG2 environment
- grid5.mif.vu.lt – gLite environment

VU MIF cluster consist form 32 nodes, now shrunk to 22 nodes and in the future is going to be about 100 cores (waiting for Sun x4100 computers, with Infiniband interconnect).

2.4. POLAND

2.4.1. History

IFJ PAN, CYFRONET:

The BalticGrid project is a continuation of more than 3-years-old active participation of Polish partners from Cracow in Grid Technologies. In 2003 the scientists from Institute of Nuclear Physics Polish Academy of Sciences together with staff of Academic Computer Centre CYFRONET AGH took part in EU CrossGrid project where ACC CYFRONET was the coordinator of the initiative. The first cluster in a rack of 1U dual-CPU machines was purchased to serve as a testbed for the project's middleware and application developers. In April 2004 the EU EGEE project has started invigorating exploitation and expansion of the grid infrastructure. Around that date and later several other grid projects with Polish partners participation began (KWfGrid, CoreGrid, ViroLab). All these activities attracted researchers from many domains who constituted a substantial experience base. From 2001 the scientific community has the perfect possibility to share grid experience at Cracow Grid Workshop conferences hosted with significant contribution of IFJ PAN. Around the BalticGrid kickoff ACC CYFRONET was running more than 200 CPUs being used by researchers from IFJ PAN, pharmacy and computational chemistry to name only a few.

PSNC:

Poznań Supercomputing and Networking Center (PSNC) is a HPC Center, Systems and Network Security Center as well as R&D Center of New Generation Networks, Grids and Portals. PSNC is also the operator of Polish National Research and Education Network PIONIER, operator of Poznan Metropolitan Area Network POZMAN.

From its very beginning, the Grid concept is one of the most developing domains at PSNC. There are active computer science research groups working on aspects such as: middleware, tools and methods for Grid computing, resource management for Grids, large scale Grid applications, user accounting on the Grid, Grid security mechanisms and policies, Grid fabric management tools, etc. PSNC has participated in many European and national projects focused on grid research e.g.: GridLab (IST-2001-32133, PSNC was the project coordinator), CrossGrid (IST-2001-32243), GridStart (IST-2001-34808), PROGRESS (led by PSNC co-funded by SUN Microsystems), Virtual Laboratory, SGIGrid (close collaboration with Silicon Graphics Inc.). PSNC was also an active participant of many international conferences and forums (including the Global Grid Forum).

2.4.2. Current situation

At the beginning of BalticGrid, IFJ PAN took an effort to make the grid resources hosted by ACC CYFRONET AGH available to the scientists from the project. As a result the BalticGrid virtual organization was enabled on both production clusters giving access to around 10% of IA32 and IA64 Itanium-2 based machines. The idea behind was to facilitate process of migration of user's applications to grid and provide the scientists with the possibility to test their application in real production grid environment while the BalticGrid infrastructure was being formed. Until today there has been over 1800 jobs running from BalticGrid VO on both clusters.



Apart of that, IFJ PAN decided to set up a minimal grid site which allows the staff to get acquainted with procedures on production infrastructure and prepare to run a large production cluster in the future. After 3 months of initial setup phase the site is being registered in GOC DB now. We expect that in September 2006 the site will follow EGEE production operations requirements. The Institute's plans are to buy more resources, expand the current site and make it available to use within EGEE/BalticGrid project collaboration.

PSNC:

Currently, beside BalticGrid, PSNC is participating in 10+ European projects related to grid computing and new generation networks e.g.: gEclipse, int.eu.grid, EGEE, RinGrid (PSNC is project coordinator), HPCEuropa, CoreGrid, Phosphorus, Express, ACGT, 6NET, GN2. PSNC is still taking a part in international conferences, forums and organizations (GGF, e-IRG, etc). The PSNC high performance computing infrastructure consists of several supercomputers (e.g. SGI Onyx 2, SGI Origin 3800, SGI Altix) and clusters:

- based on Intel Itanium2 (126 two-processor nodes), which is shared within EGEE and BalticGrid infrastructure;
- based on AMD64 Opterons (43 two-processor, dual-core nodes) which is shared within EGEE infrastructure (but foreseen for sharing also in BalticGrid);

2.5. SWEDEN

2.5.1. History

PDC at KTH has served as a Swedish national computing centre since 1989. PDC was early to adopt and perform research on parallel computers. Since these days early adoption of novel technology has been a hallmark of the activity at the centre.

PDC is member of the Swedish Infrastructure for Computing (SNIC). SNIC is the body under the Swedish Research Council that is organising and funding Swedish High-Performance Computing sites. Presently six sites around Sweden are members of SNIC. Three of the sites has a general national scope and are running a variety of larger machines such as big clusters and SMP computers. All six sites are involved in a national Grid Testbed project, Swegrid. Three of these sites, whereof KTH is one, are also part of EGEE and contribute personnel to the EGEE Northern Europe Regional Operating Centre.

2.5.2. Current situation

KTH contributes about 85 compute nodes to BalticGrid by supporting the BALTICGRID VO on the EGEE cluster in Stockholm. KTH is also leading the EGEE Northern Europe Regional Operating Centre and can in this way serve as a direct link between BalticGrid operations and the EGEE operations organisation. .

2.5.3. Current situation

PDC has contributed access to one of its clusters with 87 CPUs.

2.6. CERN



2.6.1. History

CERN, the European Organisation for Nuclear Research, funded by 20 European nations, is constructing a new particle accelerator on the Swiss-French border on the outskirts of Geneva. When it begins operation in 2007, the Large Hadron Collider (LHC) will be the most powerful machine of its type in the world, providing research facilities for several thousand High Energy Physics (HEP) researchers from all over the world.

CERN has a reputation for being at the forefront of networking technology. CERN is the place "where the Web was born". When it comes to Grid technology, this is particularly true: CERN is leading some of the most ambitious Grid projects in the world. CERN has chosen Grid technology to solve this huge data storage and analysis challenge and the CERN management has decided to refocus on the Grid the entire computing plans for the evolution of CERN computing.

CERN is in a unique ideal position to be a research centre with the flexibility and the skills to embark in advanced Research and Development projects, but with severe industrial production service requirements. CERN has also a long tradition of collaboration with industry in the IT domain often in the framework of EU supported research programmes.

To build and operate a permanent European Grid infrastructure that can serve a broad spectrum of applications, CERN is leading the pan-European consortium Enabling Grids for e-Science (EGEE). Grid software developed as part of EGEE will be used for the LHC Computing Grid, but its Grid infrastructure will extend beyond particle physics.

2.6.2. Current situation

As EGEE lead partner and a partner in many other Grid projects, CERN aims to ensure good support in middleware deployment and operation, and acts as liaison between these projects and the different EGEE activities. For BalticGrid, CERN is not providing any hardware or cluster resources to the production infrastructure. As described in the DoW, CERN provides technical support in the deployment, configuration and installation of EGEE middleware services. CERN is also providing support in monitoring and maintaining these services. When needed CERN is also able to provide support for upgrades of existing services and new service releases.



3. INSTALLATION OF MIDDLEWARE

In the beginning of the project, there were discussions about which middleware to use for future developments. Before the BalticGrid project, the middleware used in Baltic States were NorduGrid ARC and Condor and there was some knowledge about those. The middleware used at Baltic Grid had to be compatible with EGEE infrastructure, have well-functioning development and support teams and large user base. NorduGrid ARC and Condor did not work well together with EGEE infrastructure, that did lead us to LCG2,, which is used at more than 200 sites worldwide.

There were some problems with that choice. LCG2 is large software developed by various scientific groups in several countries, therefore parts of the software code are of less quality than others. It is bound to Scientific Linux, other Linux distributions are not supported, let alone other operating systems like Sun Solaris or Microsoft Windows. After discussions the LCG2 middleware was still chosen.

First installations were made in VU, NICPB and EENet sites with help from Polish and Swedish partners and CERN. Following sites got already some support from Baltic partners. Most of the support work was done via BalticGrid SA1 mailing list and direct contacts via e-mail and telephone were used.

For closer collaboration and better coordination of the SA1 activity, the weekly VRVS-meetings were started already in December 1, 2005. Those meetings are continued to this date.

KTH PDC (NEROC [7]) coordinated middleware upgrades and communication with EGEE.

There were problems with installation of LCG2.6 and LCG2.7 middleware.

- Middleware was large and slow, several services were not possible to install into one server, e.g. multiple computers were needed just for central services
- Sometimes services just stopped working and only working solution was to reinstall the service (particularly the VOMS service on voms.balticgrid.org)
- Bug reports were sent to Savannah [8], but no reply was received

gLite 3 middleware seems to be better and it has less obscure problems. Most of the sites have upgraded to gLite 3.0. Because the gLite still does not support 64-bit hardware, the LCG 2.7 middleware is used on some sites like CYFRONET-IA64, ITPA-LCG2.



Table 1 List of versions of installed middlewares on August 2006, based on GStat [4] page:

No	Site Reports	version
1	CYF-CERTIF-TB	GLITE-3_0_0
2	CYFRONET-IA64	LCG-2_7_0
3	CYFRONET-LCG2	GLITE-3_0_0
4	EENet	GLITE-3_0_0
5	egee.man.poznan.pl	LCG-2_7_0
6	IFJ-PAN-BG	GLITE-3_0_0
7	IMCSUL	LCG-2_7_0
8	ITPA-LCG2	LCG-2_7_0
9	KTU-BG-GLITE	GLITE-3_0_0
10	KTU-ELEN-LCG2	GLITE-3_0_0
11	PDC	GLITE-3_0_0
12	RTUETF	GLITE-3_0_0
13	T2_Estonia	GLITE-3_0_0
15	UT_CS	GLITE-3_0_0
17	VU-MIF-LCG2	GLITE-3_0_0

Table 2 Timeline

Date	Event
September 28, 2005	Baltic Grid CA approved by EUGridPMA
November 1, 2005	Official start of BalticGrid project
November 23-25, 2005	Kick-off meeting in Cracow
November 28, 2005	First successful job on NICPB site reported using LCG2.6
December 1, 2005	First SA1 VRVS-meeting, VU set up Resource Broker, EENet set up balticgrid VO
December 29, 2005	NICPB registered in GOCdb
January 4, 2006	VU registered in GOCdb
January 5, 2006	EENet registered in GOCdb
January 10, 2006	KTU registered in GOCdb First BalticGrid cluster, VU-MIF-LCG2 passed all SFT tests for first time
January 24, 2006	IMCS UL, ITPA registered in GOCdb
February 2, 2006	Upgrade from LCG2.6 to LCG2.7 initiated
May 24, 2006	Upgrade from LCG2.7 to gLite 3.0 initiated
August 20, 2006	RTU registered in GOCdb



4. SUMMARY

There are quite a number of resources available for BalticGrid users at the end of the 9th project month, about 440 CPU cores and about 40 TB of storage space. The infrastructure is under constant automatic supervision and if problems occur, then those are resolved in timely manner.

Solving the problems with the installation and configuration of various software packages together with BalticGrid partners strengthened our collaboration and was a good experience for Baltic States partners.

The BalticGrid Infrastructure is ready for production jobs.



5. APPENDIX I – CATALOGUE OF HARDWARE AVAILABLE FOR BALTIC GRID

Partner	Site name, number of CPU cores, size of SE
1. KTH	PDC, 95 cores whereof 90 worker nodes , -
Central services	2 Servers CPU: Intel P4 2.8GHz MB: Supermicro P4SCE Memory: 2GB Disc: 80 GB
Computing element front-end	2 Servers CPU: Intel P4 2.8GHz MB: Supermicro P4SCE Memory: 2GB Disc: 80 GB
Computing element nodes	90 Servers CPU: Intel P4 2.8GHz MB: Supermicro P4SCE Memory: 2GB Disc: 80 GB
Storage element	1 Servers CPU: Intel P4 2.8GHz MB: Supermicro P4SCE Memory: 2GB Disc: 80 GB

2. EENet	EENet, 10 cores, 2 TB
Central services	2x Sun X2100 servers CPU: AMD Opteron 175 MB: Memory: 2GB Disc: 80GB
Computing element front-end	based on Ordi Valacan server CPU: Intel Pentium 4 HT @ 3000 MHz MB: Intel S7210TP1 Memory: 1.5GB Disc: 40GB
Computing element nodes	5 nodes CPU: 2x AMD Athlon MP @ 2000 MHz MB: Tyan 760MPX Memory: 512 MB Disc (scratch area): 10GB Special hardware: Dolphinics SCI interconnect between nodes, up to 2.5 Gbps



DSA1.3
Set up of hardware for Grid and installation of middleware

Storage element	(currently the CE frontend) CPU: 2x Intel Pentium 4 @ 3000 MHz MB: Intel S7210TP1 Memory: 1.5GB Disc: 40GB Storage description: Controller: 3ware Escalade 9500S-8 Drives: 8x 300GB SATA drives in RAID5
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3. NICPB	T2_Estonia, 100 cores, 21 TB
Central services	
Computing element front-end	Sun X2100 CPU: Opteron 175 MB: Sun Memory: 2GB Disc: 72GB
Computing element nodes	Sun X4100 CPU: 2x Opteron 275 MB: Sun Memory: 4GB Disc (scratch area): 72GB x2 Special hardware: none
Storage element	(currently the CE frontend) dCache (3 nodes, 6 pools) CPU: 6x Opteron 248 (3 machines, each 2x248 CPU) MB: Ordi provided AMD motherboard Memory: 3GB x 3 = 9GB Disc: 3x7TB = 21TB Storage description: Controller: 3ware 9550SX-8 x6 Drives: 500GB SATA disks x48

4. 1 IMCS UL	IMCSUL, 9 cores, 1 TB
Central services	Machine for RB/PX/BDII: CPU: AMD Opteron 148 2ghz MB: Memory: 2GB Disc: 160GB
Computing element front-end	CPU: AMD Opteron 148 2ghz MB: Memory: 1G Disc: 160G + 4x300G Controller: Intel ICP Vortex GDT8546RZ
Computing element nodes	CPU: AMD Opteron 148 2ghz MB: Memory: 2GB Disc (scratch area): 145G Special hardware:
Storage element	currently the same machine as CE frontend



4. 2 IMCS UL	IMCSUL-INF, 8 cores, -
Central services	
Computing element front-end	CPU: 1x AMD Opteron 148 @ 2.2ghz Memory: 1GB Disc: 160GB
Computing element nodes	CPU: AMD Opteron Dual-Core 275 @2.2ghz Memory: 4GB Disc: 120GB
Storage element	

5. IFJ PAN	IFJ-PAN-BG, CYF-CERTIF-TB, CYFRONET-IA64, CYFRONET-LCG2, about 100 cores available for BalticGrid use
Central services	Production Resource Broker supporting balticgrid VO rb1.cyf-kr.edu.pl Dual CPU: Intel(R) Xeon(TM) CPU 2.40GHz MB: Supermicro Memory: 2GB Disc: 80GB Certification Resource Broker supporting balticgrid VO - allows to submit to uncertified sites rb-uncert.cyf-kr.edu.pl running on a virtual machine.
Computing element front-end	CE for IA32 nodes: zeus02.cyf-kr.edu.pl Dual CPU: Intel(R) Xeon(TM) CPU 2.40GHz MB: Supermicro Memory: 2GB Disc: 80GB CE for IA64 nodes: ares02.cyf-kr.edu.pl Hewlett-Packard RX-2600 nodes with 1.3MHz Itanium Dual CPU: GenuineIntel Itanium 2 MB: HP Memory: 2GB HDD: 3*36GB CE for testing cluster: fwe01.ifj.edu.pl CPU: AMD Athlon(tm) 64 Processor 3000+ Memory: 1GB Disk: 160 GB
Computing element nodes	Those 3 clusters consists around 100 nodes being a selection of older and newer machines. Starting from single-CPU Pentium III 1GHz to dual-CPU Intel Xeon 2.8 GHz.
Storage element	Dual CPU: Intel(R) Xeon(TM) CPU 2.40GHz MB: Supermicro Memory: 2GB Disc: 80GB As a frontend to 14TB storage solution: disk array HP XP1200 6TB (FC HDD) + disk array HP EVA 8000



6. PSNC		egee.man.poznan.pl, 148 cores, 1 TB	
Central services			
Computing element front-end		CPU: 2x Intel Itanium 2 MB: HP Memory: 4 GB Disc: 73.4GB	
Computing element nodes	46 nodes	CPU: 2x Intel Itanium 2 MB: HP Memory: 4 GB Disc: 73.4GB	
Storage element		CPU: 2x Intel Itanium 2 MB: HP Memory: 4 GB Storage description: Controller: LSI Logic 53C1030 Drives: 1 x HP 73.4GB SCSI Model: ST373453LC	

7. VU MIF		VU-MIF-LCG2, 20 cores, 0.15 TB	
Central services		Central services machines (VOMS, RB, etc): CPU: Intel(R) Pentium(R) 4 CPU 3.60GHz MB: Intel Memory: 2GB Disc: 2x 200GB BDII is moved to Sun X4100 servers	
Computing element front-end		CE frontend (CE, SE, MON, VOBOX): CPU: IAMD Athlon(tm) 64 Processor 3500+ MB: Memory: 2GB Disc: 2x 200GB	
Computing element nodes		CE nodes: 8 nodes, computer classes CPU: Intel(R) Celeron(TM) CPU 2GHz MB: Memory: 256 MB + 1GB swap Disc (scratch area): ~35GB CE nodes: 24 nodes, computer classes CPU: Intel(R) Celeron(TM) CPU 1300MHz MB: Memory: 256 MB + 1GB swap Disc (scratch area): ~35GB Those 32 nodes were until September, now there are left: 8x 2Ghz Intel Celeron, 8x 800Mhz Intel Pentium III (Coppermine) and 6x 900Mhz Intel Celeron. In few months expected to upgrade upto 100cores (Sun X4100)	
Storage element		SE (together with CE): CPU: IAMD Athlon(tm) 64 Processor 3500+ MB: Memory: 2GB Disc: for SE 150GB	



8. RTU ETF	RTUETF, 5 cores, 1 TB
Central services	
Computing element front-end	Sun Fire X4200 CPU: AMD Opteron 248 @ 2.2 GHz MB: Sun Memory: 2 GB Disc: 4*73 GB 10K RPM SAS
Computing element nodes	5 nodes Sun Fire X2100 CPU: AMD Opteron 146 @ 2.01 GHz MB: Sun Memory: 1G Disc: 250 GB SATA Special hardware: -
Storage element	(DPM head node) CPU: Pentium D 920 @ 3 GHz MB: SE7230NH1LX Memory: 1 GB Disc: 2*80GB SATA Storage description: Drives: 5*200GB DPM disk servers(WN)

9. ITPA	ITPA-LCG2, 8 cores, -
Central services	
Computing element front-end	CPU: 2xItanium2 1.7GHz MB: HP Memory: 2G Disc: 70G
Computing element nodes	node 1 CPU: 2xItanium2 1.7GHz MB: HP Memory: 2G Disc: 70G node2: CPU: 4xItanium2 1.7GHz MB: HP Memory: 2G Disc: 70G
Storage element	

10. CERN	<i>CERN does not provide any hardware for BalticGrid project</i>
Central services	
Computing element front-end	
Computing element nodes	
Storage element	



11. KTU	KTU-ELEN-LCG2, KTU-BG-GLITE, 10 cores, 0.1 TB
Central services	
Computing element front-end	Virtualized server with XEN 3.0.2 CPU: Pentium 4 3GHz HTT MB: Intel D875PBZ Memory: 300MB (allocated from 1GB physical RAM) Disc: 5GB virtual HDD for OS, 196GB shared via PVFS2
Computing element nodes	(the same as CE frontend) CPU: Pentium 4 3GHz HTT MB: Intel D875PBZ Memory: 300MB (allocated from 1GB physical RAM) Disc (scratch area): 5GB NFS shared /home from CE frontend, 196GB PVFS2. Special hardware:
Storage element	(currently the CE frontend) CPU: Pentium 4 3GHz HTT MB: Intel D875PBZ Memory: 300MB (allocated from 1GB physical RAM) Disc: 5GB virtual HDD for OS, 196GB shared via PVFS2 Storage description: 196GB PVFS2 shared on 5 nodes. Controller: 1GB ethernet Drives: Maxtor 80GB