

Meta-cluster of distributed computing “Dubna-Grid”

Creation of a multi-purpose town
scale network of distributed
computing

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on behalf of the “Dubna-Grid” Collaboration



AGREEMENT

Between

- Administration of Dubna,
- Joint Institute for Nuclear Research,
- International University of Nature, Society and Man
“DUBNA”

Subject:

Creation of a city multi-purpose informational infrastructure of the new generation based on the Grid-technology

Project “Dubna-Grid”

Participants:

JINR

Belyakov D.V., Chkhaberidze D. Golub D.C., Dolbilov A.G., Ivanov V.V.,
Ivanov Valeri V., Kalmikova L.A., Korenkov V.V., Mitsyn V.V.,
Popov L.A., Strizh T.A., Zrellov P.V.

Dubna University

Antonov A.N., Kryukov Yu.A., Cheremisina E.N.

Administration of Dubna City

Dobromislov S.N., Rats A.A., Rybov E.B.

Lund University

Smirnova O.G.

Chicago University

Smirnov Yu.S.

Main purposes of the project

The “Dubna-Grid” Project is aimed at the creation of a distributed environment of meta-computing on the basis of vacant computing resources of “office” computers. The project foresees creation of a common pool of accessible nodes of more than 1000 units.

Implementation of the project “Dubna-Grid” will allow:

- to create a unified computing environment of the city Dubna (meta-cluster) on the basis of the resources of scientific and educational institutions, in particular, JINR subdivisions, University “Dubna”, secondary schools and other organizations;
- to create a segment of the international Grid-infrastructure, operating in frames of various Grid systems (LGG, NorduGrid and OSG);
- to provide execution of large-scale computing tasks of JINR and other enterprises of Dubna scientific – industrial complex and other organizations;
- to distribute experience of creation of the city segment of the Grid-infrastructure for creation of similar systems in Russia.

Motivation of the participating organizations

- The Joint Institute for Nuclear Research is interested in additional computing resources, in order to conduct research in frames both the current experiments and the experiments that are being prepared at the LHC.
- The University “Dubna” and MIREA are interested in training of young specialists for work with advanced information technologies.
- The city of Dubna as a City of Science, is interested in creation of informational – computational infrastructure for high-technology production and scientific research as well as for using the information technologies for solving tasks in various spheres of the city life.
- The participants from the universities of Lund and Chicago are interested in joint testing of different Grid systems.

Responsibilities of participating organizations

Administration of the Dubna city

- provides an informational – educational computer network
- upgrades the computers in computer classes of secondary schools

Responsibilities of the participating organizations

JINR

- develops and organizes a testing exploitation of the test-bed architecture
- provides pool of office computers and managing servers
- installs various Grid systems on the test-bed
- organizes a joint Grid laboratory for research in the field of Grid technologies and trains specialists of a corresponding profile

Responsibilities of the participating organizations

University “Dubna”

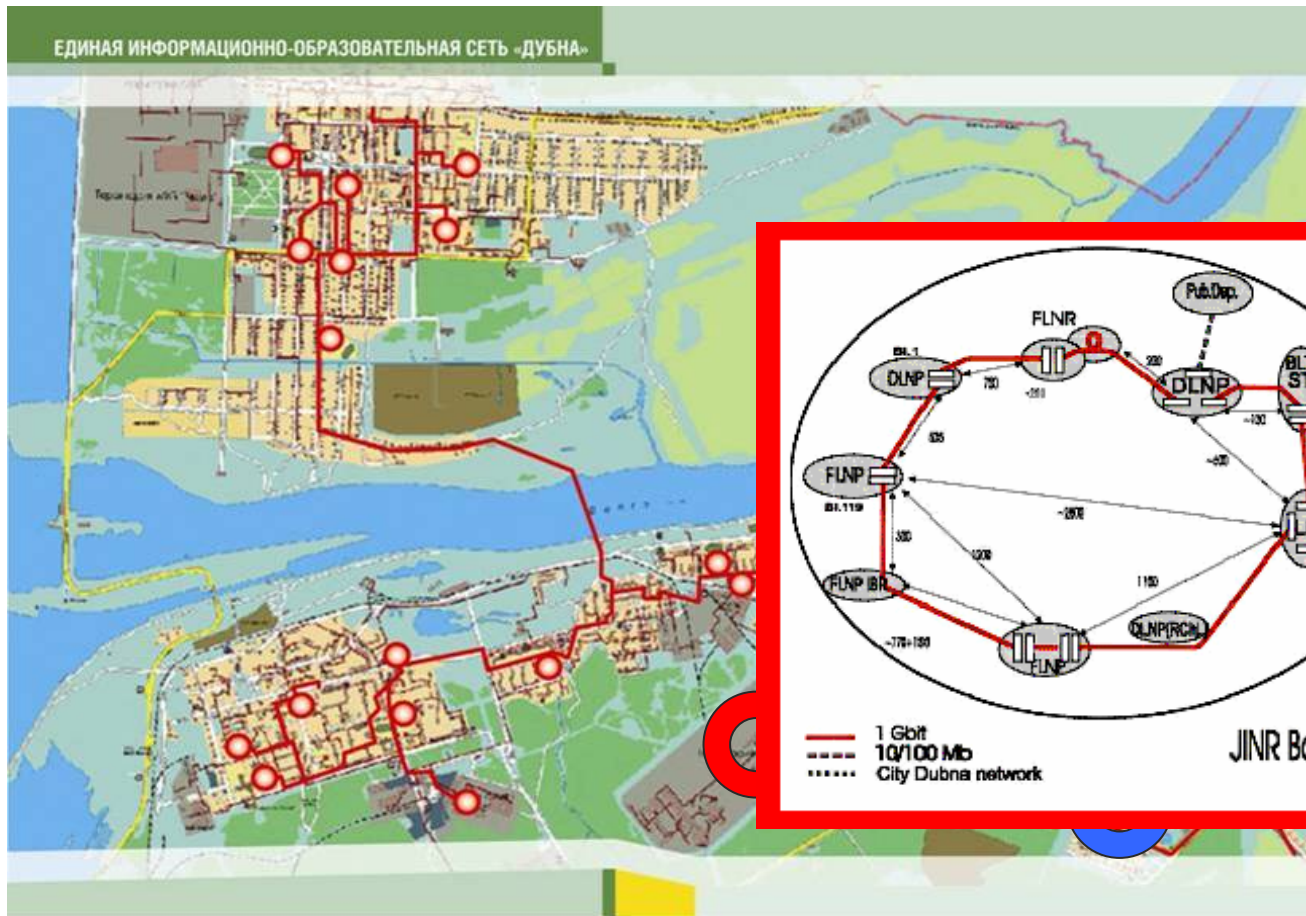
- provides 500 computers from the university network
- creates a server center for the maintenance of the university segment of the meta-cluster
- works out the courses on Grid technologies and trains specialists in frames of the joint Grid-laboratory

Main stages of Project realization

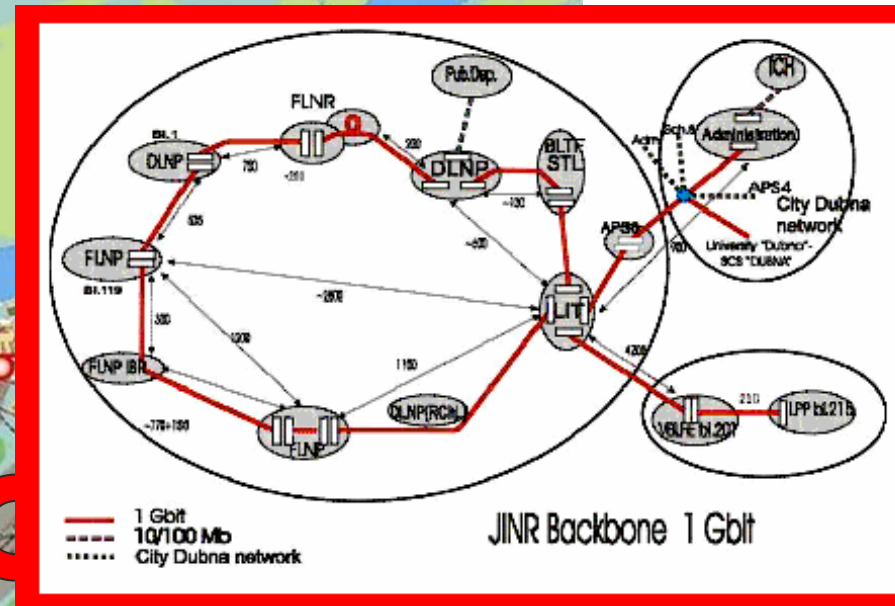
- development of technology of the meta-cluster construction on the basis of software of virtual machines
- creation of a meta-cluster prototype integrating resources of various organizations
- development of mass installation technologies and spreading software to all accessible nodes of the city infrastructure
- development of the meta-cluster monitoring system
- installation of various Grid systems at the meta-cluster
- training of specialists in the field of Grid technologies.

Network resources of the Project

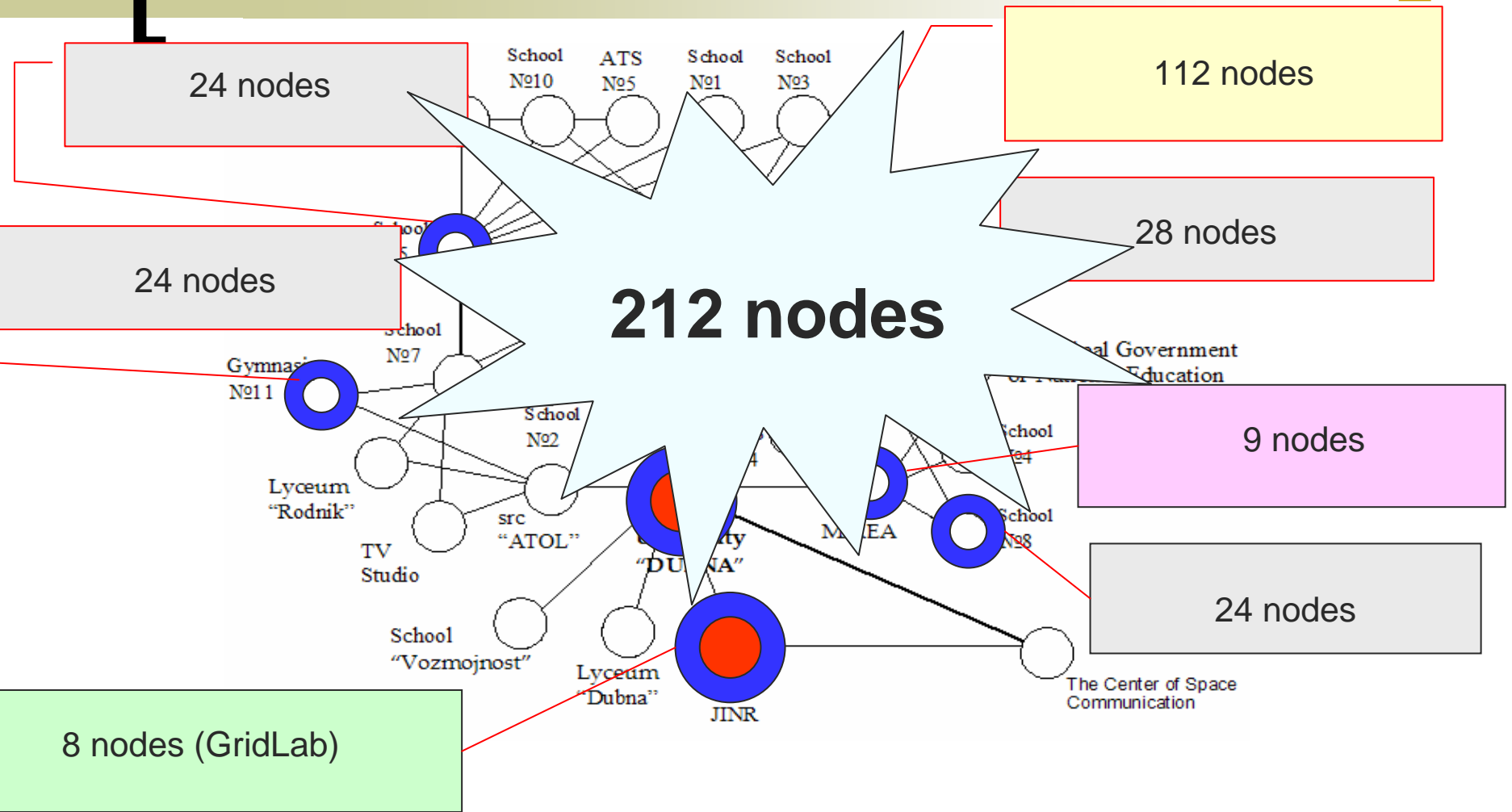
City Informational-Educational Computer Network



JINR Backbone



Current State



Construction of the system

- Dubna-Grid meta-cluster includes central server, bridge and computational nodes.
- Computational nodes represent Virtual PCs emulated by virtual machine technology (VMware).
- By means of VMware we get two computers instead of one, both have their own memory, IP address etc., but physically they use the same resources - two “machines” share one processor, memory, Ethernet card etc.

Construction of the system (cont'd)

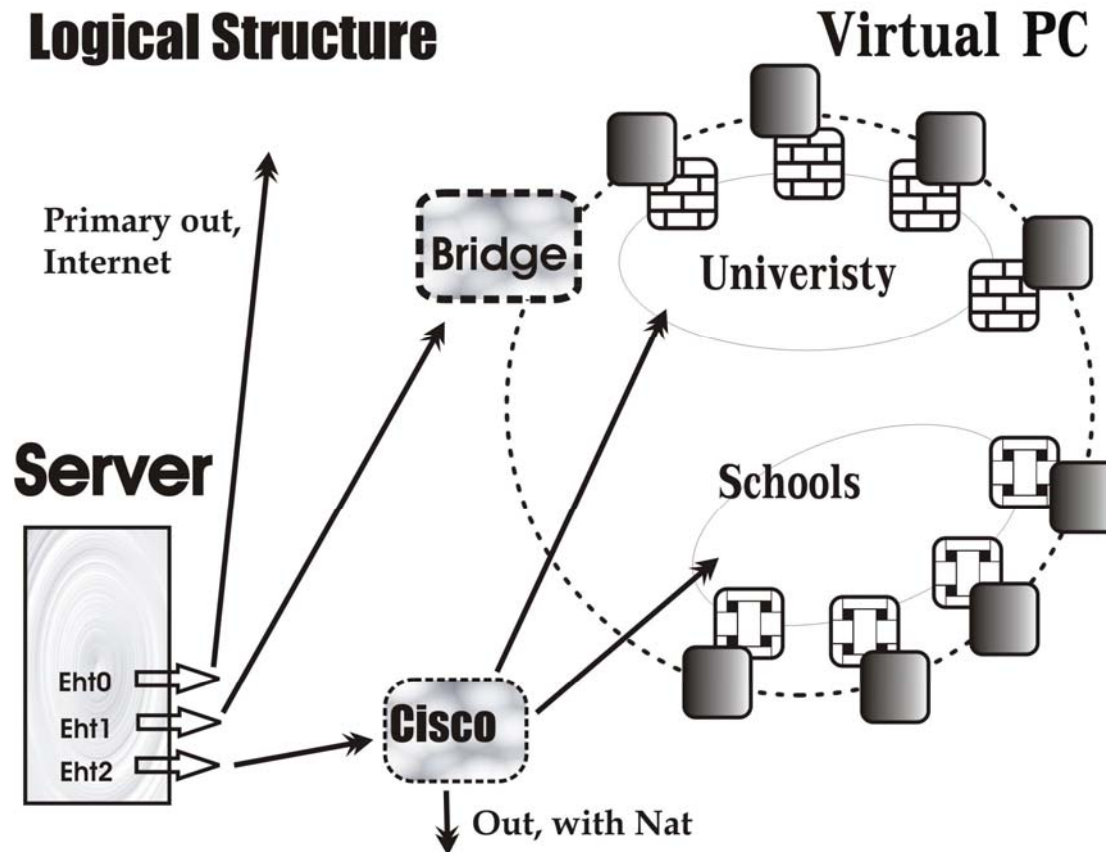
The following software tools and technologies were used:

- software support for virtual machines maintenance (VMware),
- virtual network (VLAN),
- virtual access to the software and data (AFS),
- building and loading OS images to the Virtual PCs of the meta-cluster.

On the central server the following software is installed:

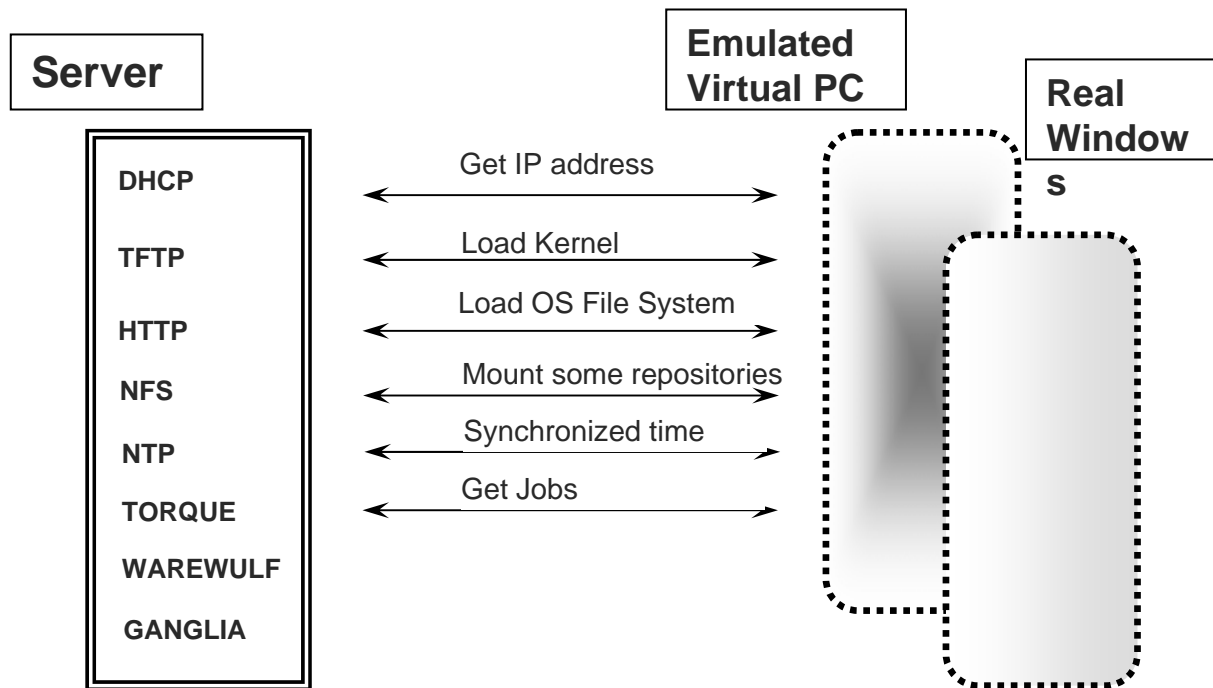
- OS Scientific Linux CERN;
- a package for support of cluster architecture Warewulf;
- Ganglia monitoring system;
- OpenAFS,
- the batch system Torque with Maui scheduler.

Logical scheme of the “Dubna-Grid” meta-cluster

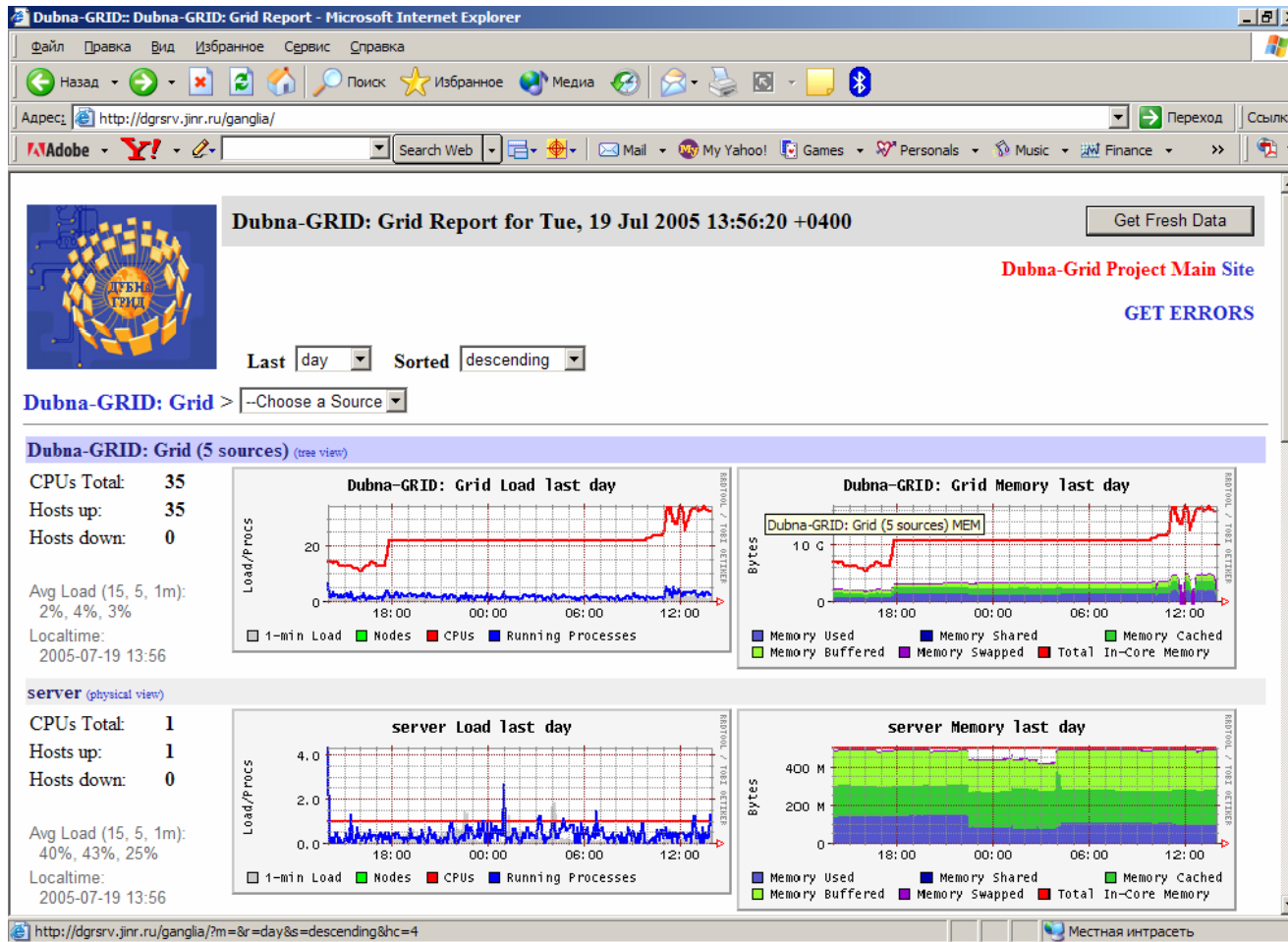


Schematic view of loading the computing node

Loading Process



Monitoring of the "Dubna-Grid" Meta-Cluster



Test infrastructure at JINR

Tasks:

- Check-up and test exploitation of new versions of the software for nodes and servers of the meta-cluster
- Installation of various Grid-systems
- Training of specialists in the field of Grid technologies

Creation of the test complex is taking place in the framework of the project of the joint Grid laboratory “GridLab” at LIT JINR

The Project Parameters

Parameters/ years	2005	2006	2007	2008
A number of Grid nodes involved	200	500	1000	1500

How to submit job to the meta-cluster?

- Using batch system of the JINR Central Information and Computer Complex (CICC)
- Using web-interface for some specific tasks (now it is in test mode for the project **HIGH Energy Physics WEB at LIT (HEPWEB server)**)

The main aim of this project is to perform Monte-Carlo simulations of high energy physics processes, and to evaluate the main properties of the hadron-hadron and nucleus-nucleus interactions using WEB access to LIT computer resources in the framework of the JINR participation in LCG program (GENSER).

<http://hepweb.jinr.ru>

High Energy Physics WEB at LIT

LABORATORY of INFORMATION TECHNOLOGIES
HEPWEB

Monte Carlo Simulation Tools for High Energy Physics

The page allows you to perform Monte Carlo simulations of high energy physics processes, and to evaluate the main properties of interactions: hadron-hadron, hadron-nucleus and nucleus-nucleus interactions.

Monte Carlo models
of hadron-hadron, hadron-nucleus and nucleus-nucleus interactions.

(last update 15.03.06)

CASCADE	- intra-nuclear cascade model	$1 < \text{Plab} < 20 \text{ GeV/c}$
FRITIOF	- wounded nucleon model	$10 < \text{Plab} < 1000 \text{ GeV/c}$
UrQMD 1.3	- ultra-relativistic quantum molecular dynamic model	$1 < \text{Plab} < 1000 \text{ GeV/c}$
UrQMD 1.3+SMM	- ultra-relativistic quantum molecular dynamic model + statistical multi-fragmentation model (in development)	$1 < \text{Plab} < 1000 \text{ GeV/c}$
HIJING	- high energy jet production model	$50 \text{ GeV/c} < \text{Plab}$

Cross section estimation methods

[Glauber approximation](#)

[Reggeon approximation](#)

HEPWEB: Interfaces to generators

Search the HJING database - Microsoft Internet Explorer

Address http://hepweb.jinr.ru/hjing_0_1/

HJING - A Monte Carlo Program for parton and particle production in high energy hadronic and nuclear collisions

The page allows you to perform Monte Carlo simulations of hadron-hadron, hadron-nucleus and nucleus-nucleus interactions.

Choose the projectile and target

Projectile	Nucleus	Mass number	1	Charge	1
Target	Nucleus	Mass number	1	Charge	1
Impact parameter Min	0.	Max	10.	Bmin, Bmax	
Number of events	10				
Minimum transverse momentum	of hard scatters 2.0 (GeV)				

Modified FRITIOF - Microsoft Internet Explorer

Address <http://hepweb.jinr.ru/fritof/fritof.html>

Modified FRITIOF

The page allows you to perform Monte Carlo simulations of hadron-hadron, hadron-nucleus and nucleus-nucleus interactions.

Choose the projectile and target

Projectile	Nucleus	Mass number	4	Charge	2
Target	Nucleus	Mass number	12	Charge	6
Arbitrary impact parameter	Bmin	0.	Bmax	10.	
Nuclear destruction parameter- strong (1) or weak (0)	CND	0.2			
Fermi momentum in GeV/c	0.2				

ALL PARTICLES PRODUCED AND THEIR DECAY PRODUCTS ARE RECORDED

Reference frame Lab. system | Plab or Sqrt(s) in GeV 4.2

CASCADE model by Zh. Musulmanbekov - Microsoft Internet Explorer

Address <http://hepweb.jinr.ru/cascade/cascade.html>

CASCADE - intra-nuclear cascade-evaporation model

The page allows you to perform Monte Carlo simulations of hadron-nucleus and nucleus-nucleus interactions.

Choose the projectile and target

Projectile	Nucleus	Mass	4	Charge	2	Plab	4.5	GeV/c/nucleon
Target	Nucleus	Mass	12	Charge	6	Target is at rest		
Arbitrary impact parameter	Bmin	0.	Bmax	10.				
Number of generated events	1000							

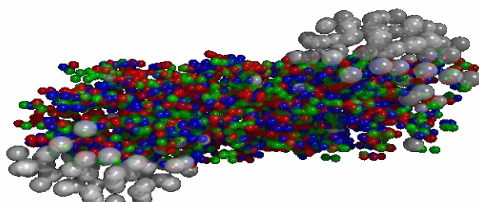
The code can not manage with hadron-hadron interactions!

Get results

UrQMD-Homepage - Microsoft Internet Explorer

Address http://hepweb.jinr.ru/urqmd1_3/urqmd1_3.html

The Ultrarelativistic Quantum Molecular Dynamics model is a microscopic model used to simulate (ultra)relativistic heavy ion collisions in the energy range from Bevalac and SIS up to AGS, SPS and RHIC.

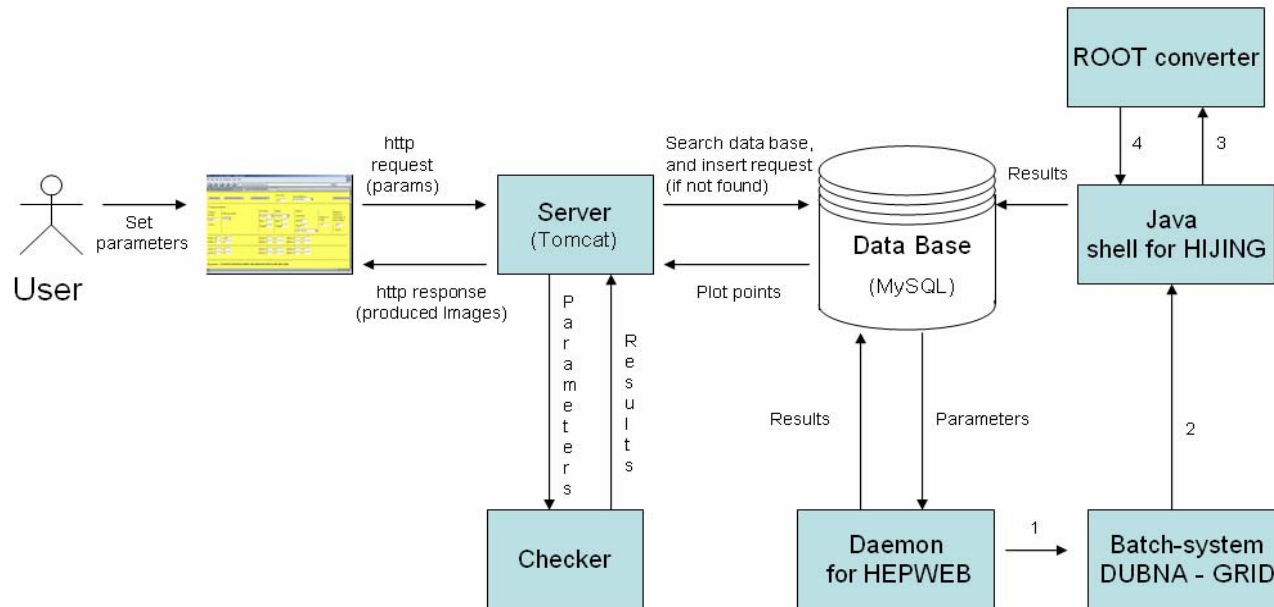


The page allows you to perform Monte Carlo simulations of hadron-hadron, hadron-nucleus and nucleus-nucleus interactions.

Choose the projectile and target

Projectile	Nucleus	Mass number	1	Charge	1
Target	Nucleus	Mass number	1	Charge	1

Integration of HEPWEB server in DUBNA-GRID enviroment



1 – script file for Batch system + parameters

3 – HBOOK file

2 – results from generators + results from Batch-system

4 – ROOT file

Organization problems

- Provision of round-the-clock operation of the meta-cluster nodes, requires control over temperature and installation of an improved ventilation or air-conditioning systems
- Necessity of setting up fire-alarm networks and organization of a round-the-clock monitoring in frames of the whole city.
- Training of system administrators of computer classes.

Conclusion

- A test-bed of distributed meta-computing environment of Dubna city based on vacant computing resources of office computers of scientific and educational institutions has been created.
- Mass installation technologies and spreading software to all accessible nodes of the meta-cluster have been developed.
- Monitoring system of the meta-cluster has been developed.
- The meta-cluster have been integrated with JINR batch system.
- First real tasks have been performed (including real tasks for the ATLAS experiment).
- Integration of HEPWEB server in DUBNA-GRID environment is realized.