Distributed Computing in Armenia: Current Status and Perspectives

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First ATLAS-South Caucasus Software/Computing Workshop & Tutorial

26 October 2010, Tbilisi, Georgia

Overview

- Armenian Grid Infrastructure
- Armenian National Grid Initiative
- International and National Projects: Recent & Upcoming
- Heavy User Communities

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- **Armenian Grid Infrastructure**
- Armenian National Grid Initiative
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Armenian Grid Infrastructure: ASNET AM Network

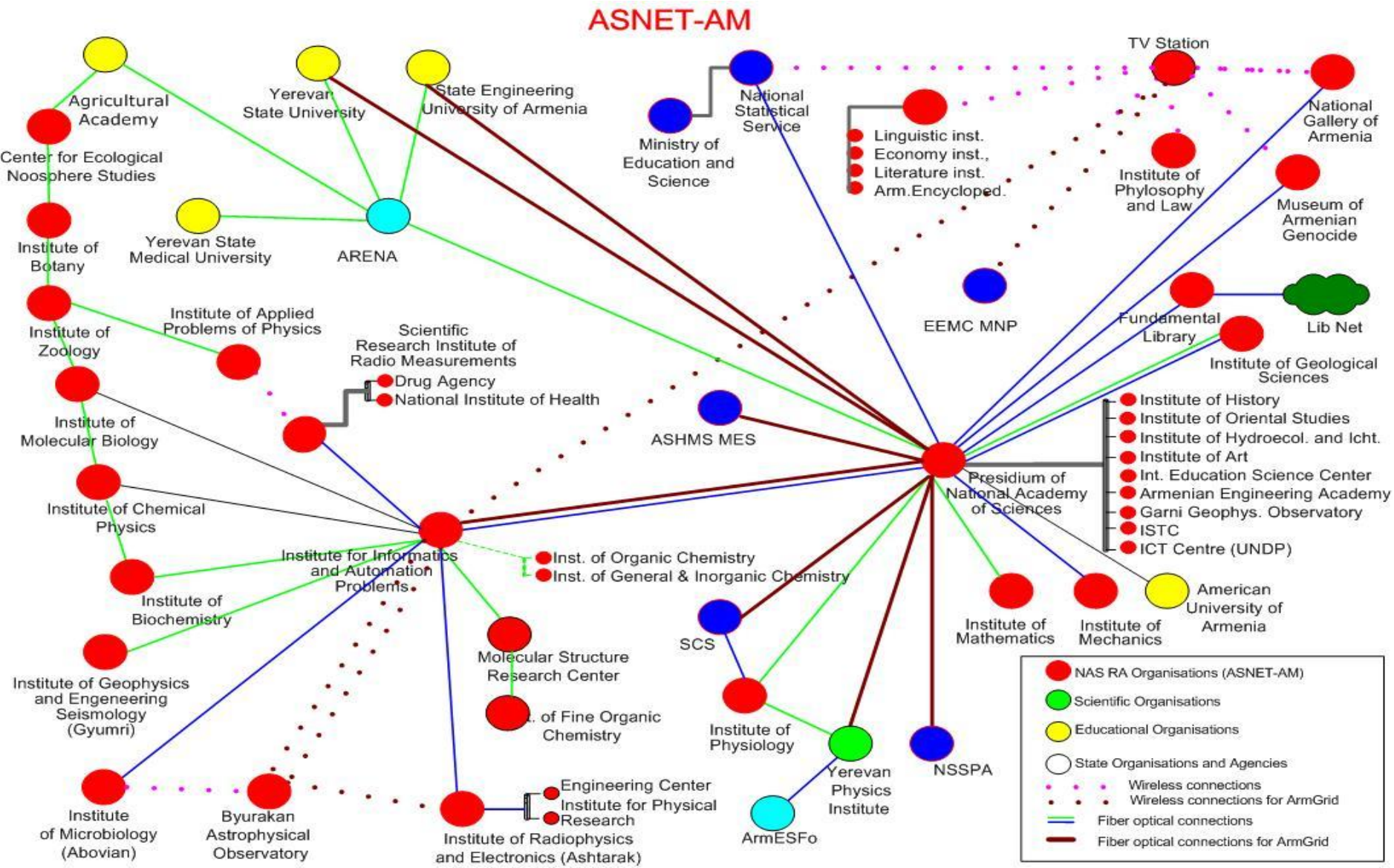
ASNET-AM was started to develop and realize since 1994 by the **Institute for Informatics and Automation Problems (IIAP NAS RA).**

ASNET-AM interconnects scientific-research and educational organizations in the major cities of Armenia, such as Yerevan, Ashtarak, Byurakan, Abovian, Gyumri.

The international connection for ASNET-AM is provided by GEANT, as well as dedicated channel rented from the local telecom companies (Arminco, ADC).

ASNET-AM unifies more than 50 academic, research and educational organizations.

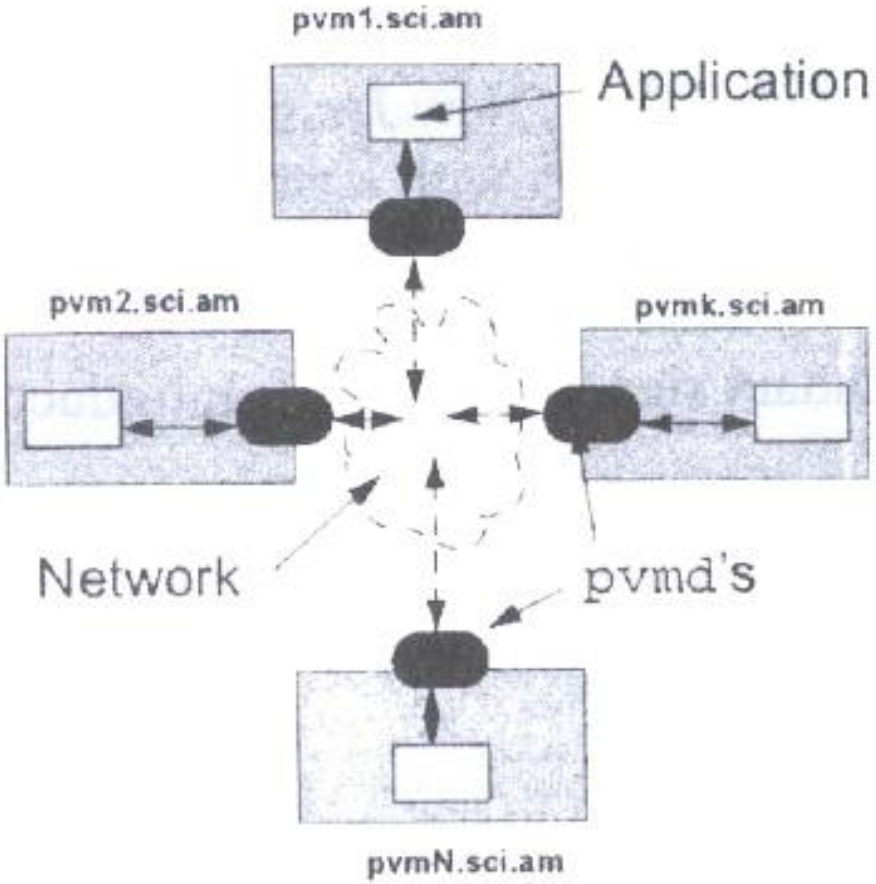
Armenian Grid Infrastructure: ASNET AM Topology



Armenian Grid Infrastructure: 2001

Web based management environment based on PVM

(using module programming techniques)

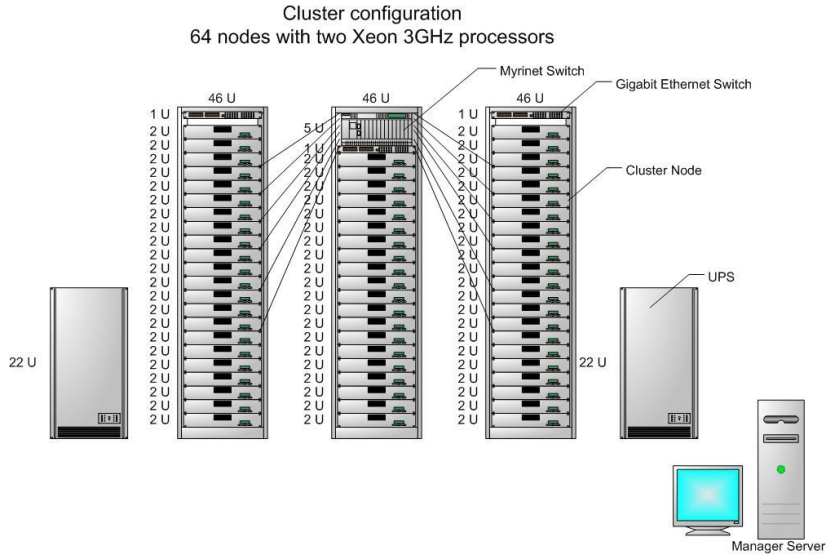


Armenian Grid Infrastructure: 2004

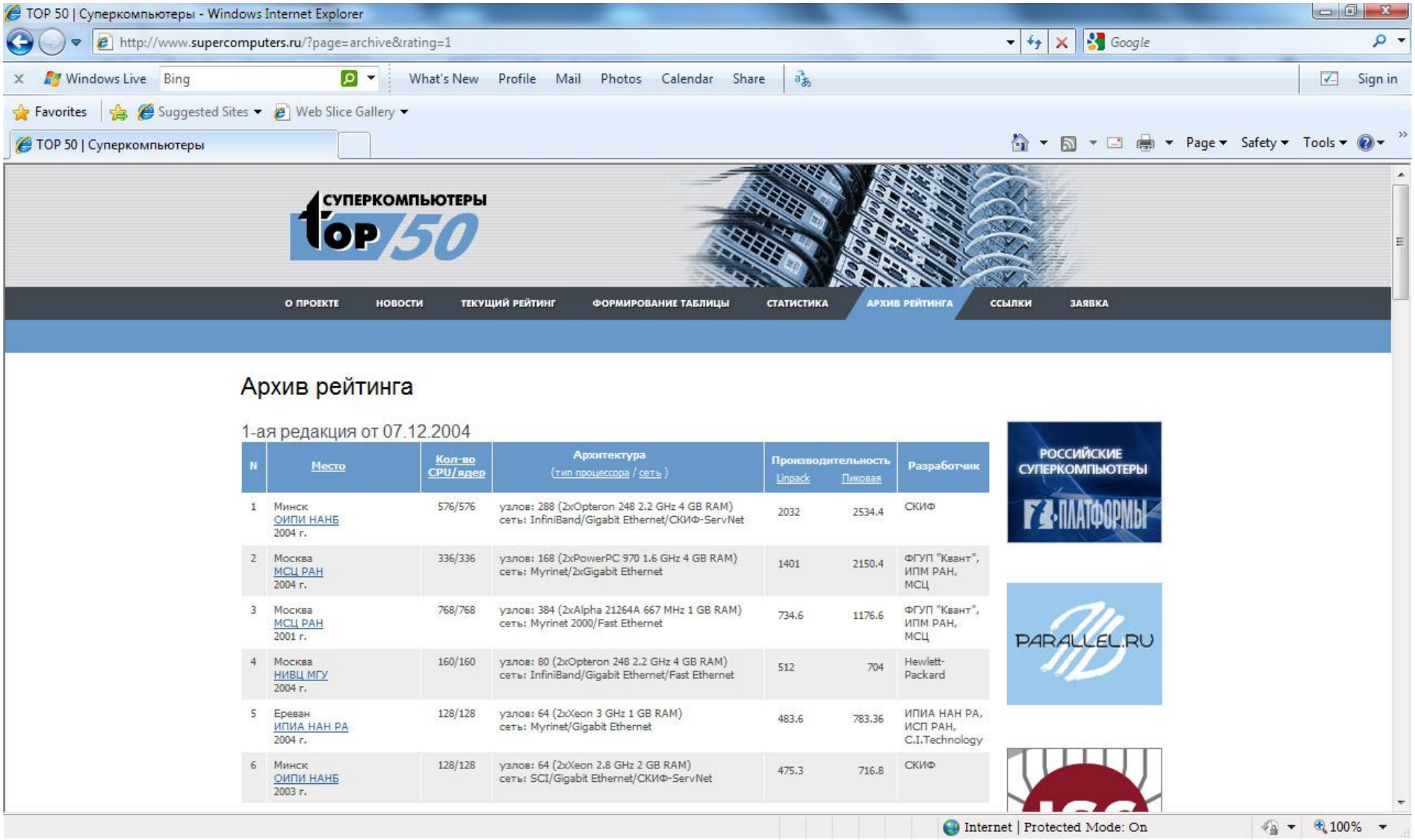
The First High Performance Computational System (ArmCluster) in the South Caucasus

Date installed: 04.04.2004

- Nodes/Processors: 64/128
- Processor: Type: Intel Xeon 3.06.GHz
- Interconnect Type: Myrinet, Gigabit Ethernet
- Peak Performance: 783.36 Gflops
- Measured Performance: 523.6 Gflops



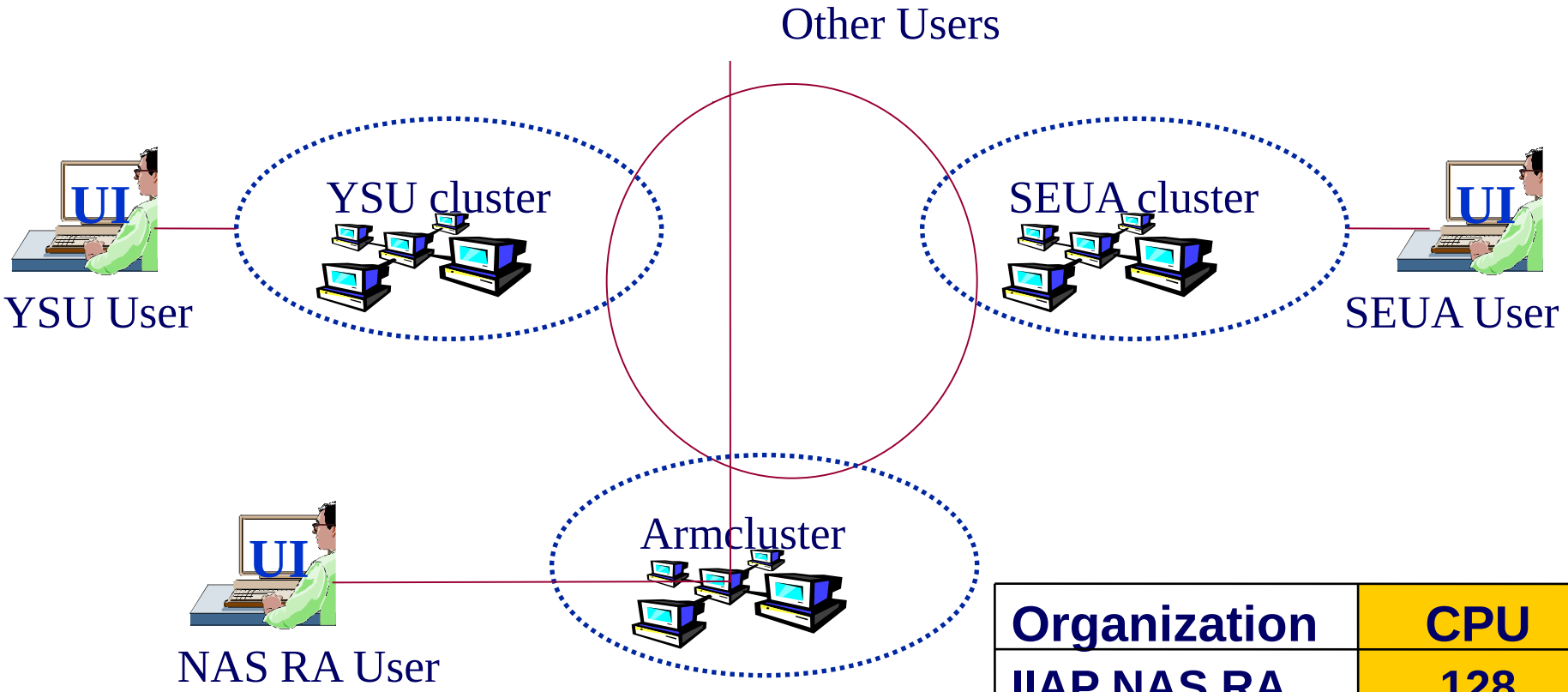
Armenian Grid Infrastructure: Armcluster -2004



N	Место	Кол-во CPU/ядер	Архитектура (тип процессора / сеть)	Производительность Linpack	Производительность Пиковая	Разработчик
1	Минск ОИПИ НАНБ 2004 г.	576/576	узлов: 288 (2xOpteron 248 2.2 GHz 4 GB RAM) сеть: InfiniBand/Gigabit Ethernet/СКИФ-ServNet	2032	2534.4	СКИФ
2	Москва МСЦ РАН 2004 г.	336/336	узлов: 168 (2xPowerPC 970 1.6 GHz 4 GB RAM) сеть: Myrinet/2xGigabit Ethernet	1401	2150.4	ФГУП "Квант", ИПМ РАН, МСЦ
3	Москва МСЦ РАН 2001 г.	768/768	узлов: 384 (2xAlpha 21264A 667 MHz 1 GB RAM) сеть: Myrinet 2000/Fast Ethernet	734.6	1176.6	ФГУП "Квант", ИПМ РАН, МСЦ
4	Москва НИВЦ МГУ 2004 г.	160/160	узлов: 80 (2xOpteron 248 2.2 GHz 4 GB RAM) сеть: InfiniBand/Gigabit Ethernet/Fast Ethernet	512	704	Hewlett-Packard
5	Ереван ИПИА НАН РА 2004 г.	128/128	узлов: 64 (2xXeon 3 GHz 1 GB RAM) сеть: Myrinet/Gigabit Ethernet	483.6	783.36	ИПИА НАН РА, ИСП РАН, C.I.Technology
6	Минск ОИПИ НАНБ 2003 г.	128/128	узлов: 64 (2xXeon 2.8 GHz 2 GB RAM) сеть: SCI/Gigabit Ethernet/СКИФ-ServNet	475.3	716.8	СКИФ

Armenian Grid Infrastructure: 2006

Experimental Scientific-Educational Grid Infrastructure (Globus)



Organization	CPU
IIAP NAS RA	128
SEUA	4
YSU	2
Totals	134

Armenian Grid Infrastructure: 2009-2010

Prototype of the Armenian National Grid Infrastructure - 2009

Organization	Cores
IIAP NAS RA	176
Yerevan State University	104
State Engineering University	48
IRPHE NAS RA	48
Total	**376**

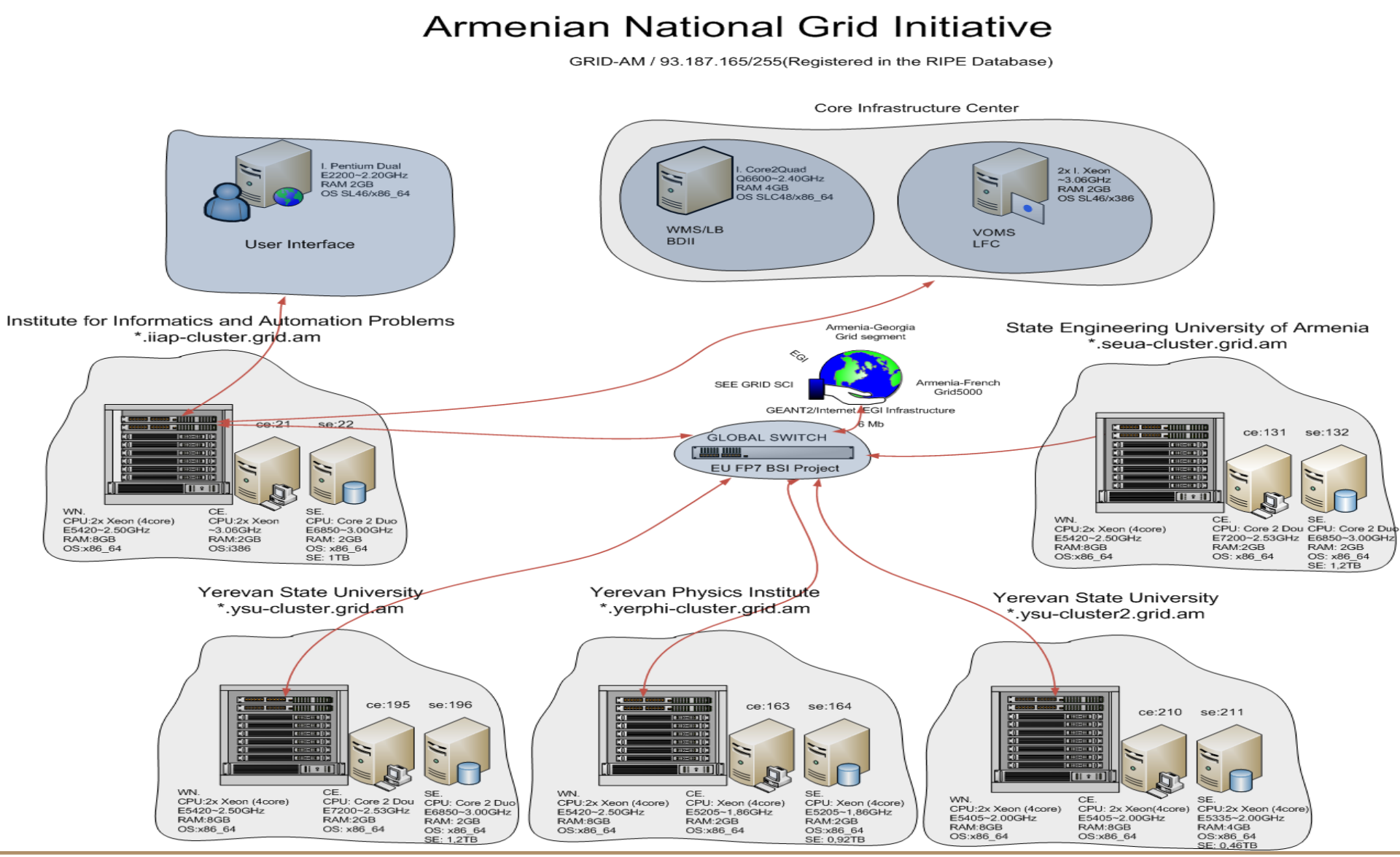
Upgrade of the Armenian National Grid Infrastructure

Organization	Cores
Computational Resources, 2009	376
Yerevan Physics Institute	48
Total	**424**

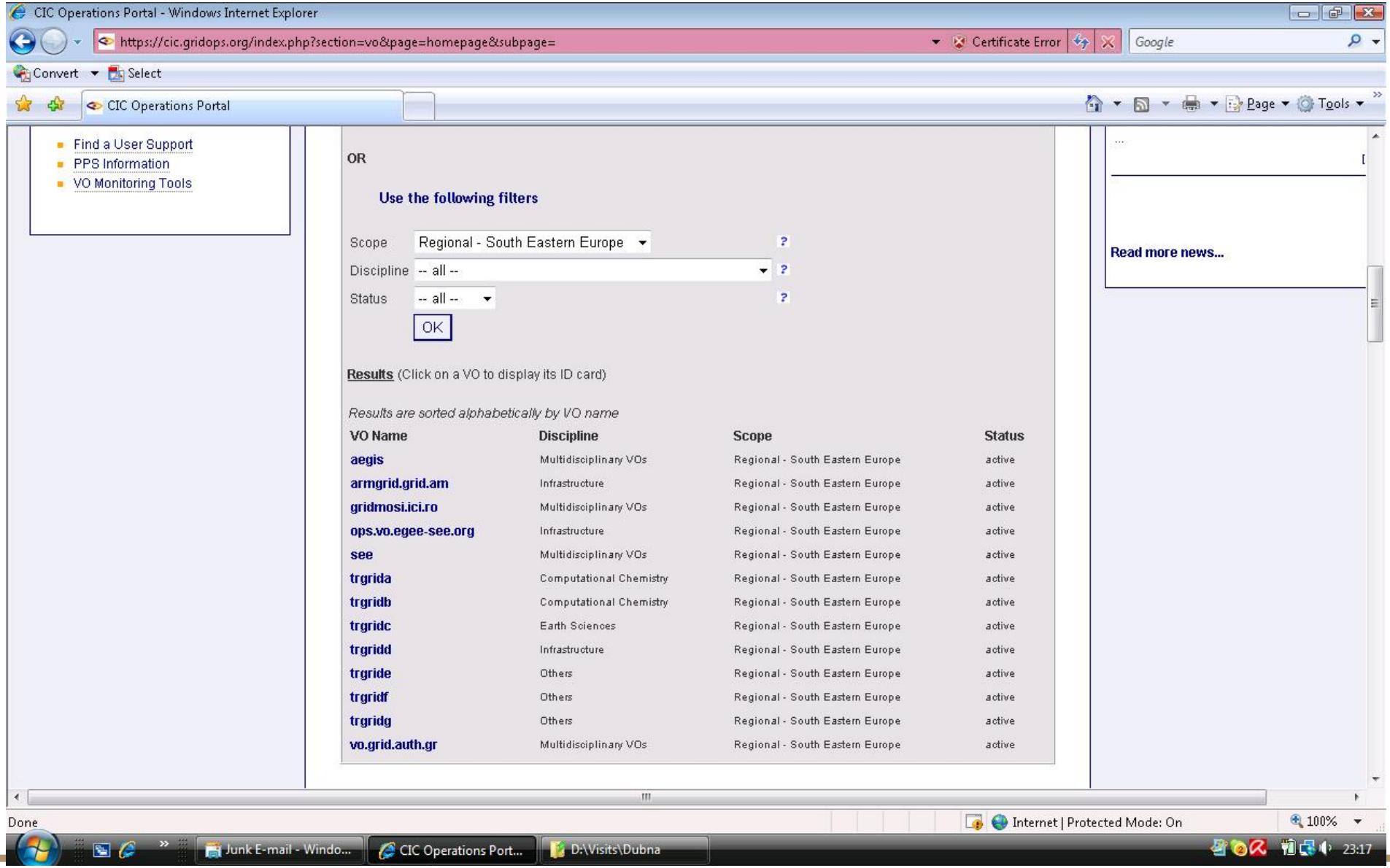
Armenian Grid Infrastructure: Core Services

R-GMA
AMGA
P-GRADE
GANGLIA

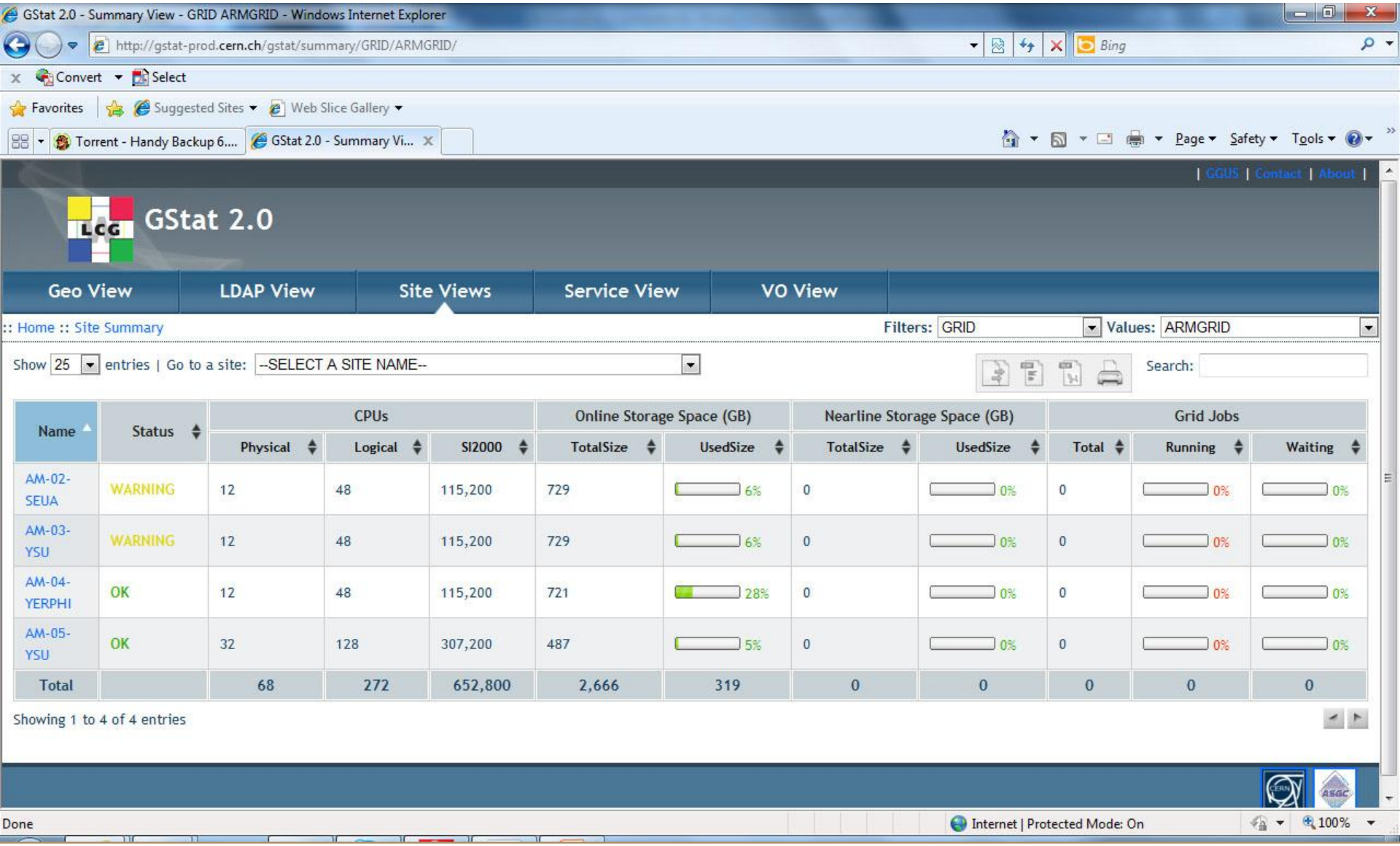
Armenian Grid Infrastructure: Topology



Armenian Grid Infrastructure: ARMGRID.GRID.AM VO



Armenian Grid Infrastructure: Infrastructure Transition to EGI



Name	Status	CPUs			Online Storage Space (GB)		Nearline Storage Space (GB)		Grid Jobs		
		Physical	Logical	SI2000	TotalSize	UsedSize	TotalSize	UsedSize	Total	Running	Waiting
AM-02-SEUA	WARNING	12	48	115,200	729	6%	0	0%	0	0%	0%
AM-03-YSU	WARNING	12	48	115,200	729	6%	0	0%	0	0%	0%
AM-04-YERPHI	OK	12	48	115,200	721	28%	0	0%	0	0%	0%
AM-05-YSU	OK	32	128	307,200	487	5%	0	0%	0	0%	0%
Total		68	272	652,800	2,666	319	0	0	0	0	0

Armenian Grid Infrastructure: GPU Computing

The Tesla C1060 is based on the massively parallel, many-core Tesla processor, which is coupled with the standard CUDA C programming environment to simplify many-core programming.

Overview

- Armenian Grid Infrastructure
- **Armenian National Grid Initiative**
- International and National Projects: Recent & Upcoming
- Heavy User Communities

Armenian National Grid Initiative: Goals

Agreement of Establishment of Armenian Grid Joint Research Unit was signed in September 2007

Main goals:

- To establish a Armenian Infrastructure presence in international Grid infrastructures.
- To develop local know-how and expertiseon the development and operation of Grid technologies.
- To promote the uptake of Grid technologies in Armenia, the interconnection of existing and future resources, and the deployment of new applications.
- To support researchin Grid and Global Computing.

Armenian National Grid Initiative: Overview

- ArmNGI Foundation Kick-off meeting in October 2008.
- Governmental decision, 2010

- State Scientific Committee
- National Academy of Sciences
- State Engineering University of Armenia
- Yerevan State University
- Yerevan Physics Institute after A. Alikhanian
- Institute for Informatics and Automation Problems of the National Academy of Sciences
- Armenian e-Science Foundation

Armenian National Grid Initiative: Activities

- Infrastructure Management and Operation
  - Grid service in Armenia as of 2008
  - Production-quality service as of 2009
- Certification Authority and User Access
  - Security and Digital Certificates (keys to the Grid)
- Application Deployment
  - Help Armenian scientists to gain access to and make use of the Grid
  - Invite and support local applications: medicine (IC), computer science, applied mathematics, chemistry, physics
- Training and Dissemination

Armenian National Grid Initiative: Structures

ArmGrid software comprises:

- user tools (portals, systems for applications management and monitoring, result visualization and other purposes, compatible with the lower-layer software used in ArmGrid);
- software libraries;
- virtual organization systems: certificates, accounting, security;
- data management systems: metadata catalogues, replica management, file transfer;
- resource management systems: job management, applications, grid services and infrastructure monitoring, license management, local resource management.

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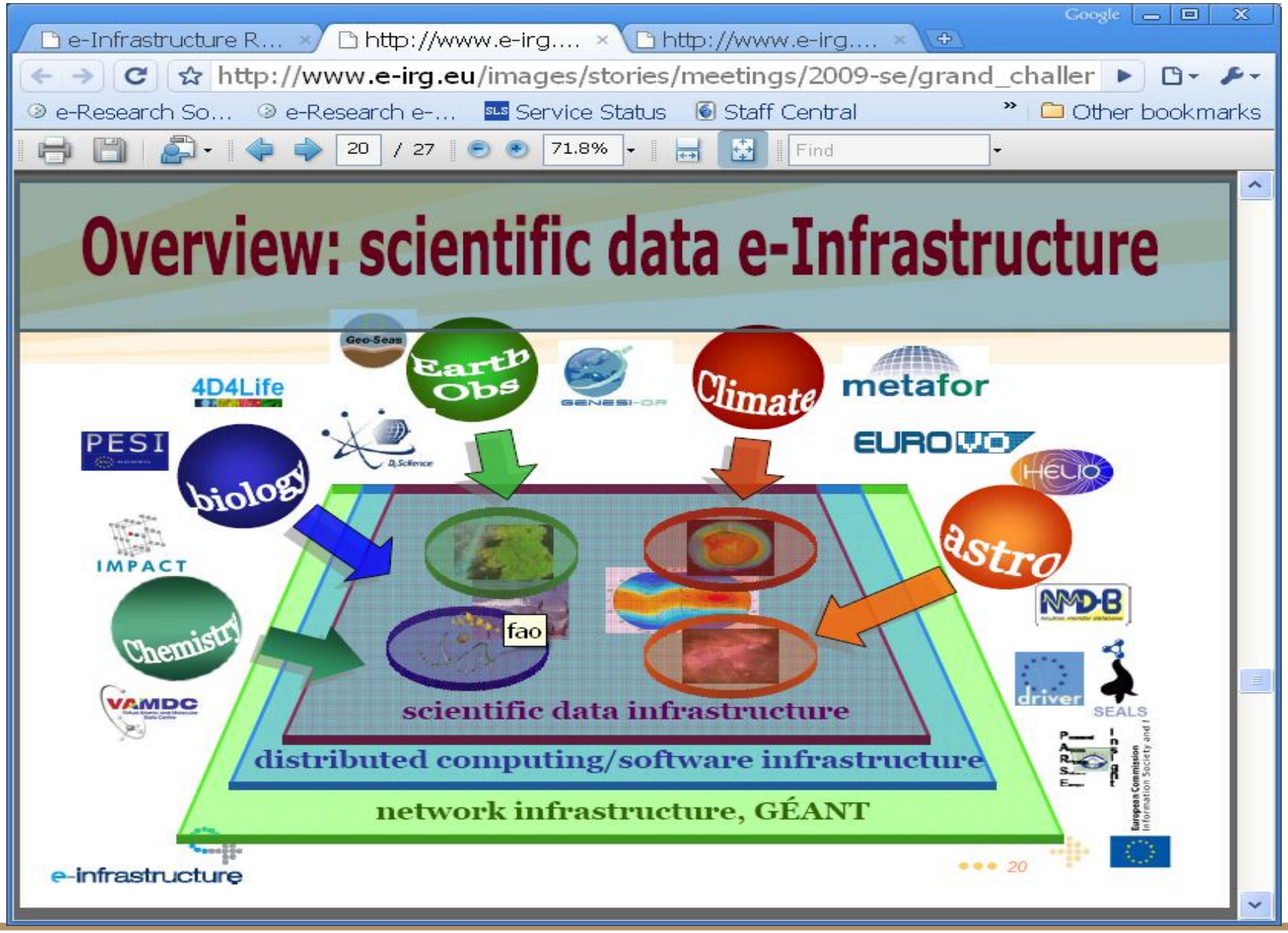
International and National Projects: Introduction



International and National Projects: Recent

Creation of High-Performance Computation Cluster and Databases in Armenia (2003-2006)

Participants

- Armenia - Institute for Informatics and Automation Problems, Yerevan Automated Control Systems Scientific Research Institute, Institute for Physical Research, National Survey for Seismic Protection of RA, Byurakan Astrophysical Observatory, Institute of Mathematics, Center of Scientific Information, Institute of Geological Sciences
- Georgia - Tbilisi State University

Expected Main Results

- A system of intellectual software packages to support the advance in the field of modeling and analysis of quantum systems, signal and image processing, theory of radiation transfer, calculation of time constants for bimolecular chemical reactions. A system of mathematically proved methods, fast algorithms and programs for solving of certain classes of problems in linear algebra, calculus, algebraic reconditibility, test-checkable design of the built-in control circuits in the machine cluster environment
- Software environment for design and real-time verification of the Global Automatic Control Systems is based on primitives, where design and verification processes are integrated. The proposed methods will be tested on a specific ACS. Separate components (such as access-classification system design means for distributed users) may be used independently.

International and National Projects: Recent

Creation of Armenian State Experimental Computing System (2005-2006)

Participants

- Institute for Informatics and Automation Problems, NAS RA; Yerevan State University (YSU); State Enineering University of Armenia (SEUA); Linguistic Institute, NAS RA

Main Results

- Providing network interaction between distributed computing resources of IIAP NAS RA, YSU and SEUA, realization of experimental fragment and development of software.
- Development of Armenian UNL module, as well as multilingual modules.

International and National Projects: Recent

BSI (Black Sea Interconnection) project intends bridging the digital divide that exists between the South Caucasus countries and Europe by establishing a regional research and education network in the South Caucasus and connecting it to GÉANT2.

The project involves the development of strategies for interconnecting the existing infrastructures in the region, realization of the connections and supplying operational support for the established network.

The existence of interconnections between the South Caucasus countries and connection to GÉANT2 with reasonable capacities will enable introduction of new services to the region and will be an important step towards the integration of the scientific potential in the region with Europe.

International and National Projects: Recent

Development of Scientific Computing Grid on the Base of Armcluster for South Caucasus Region (2007-2009)

Participants

- Institute for Informatics and Automation Problems NAS RA; Yerevan State University; State Engineering University of Armenia; Institute of Radiophysics and Electronics NAS RA; Byurakan Astrophysical Observatory NAS RA; Institute for Physical Research NAS RA

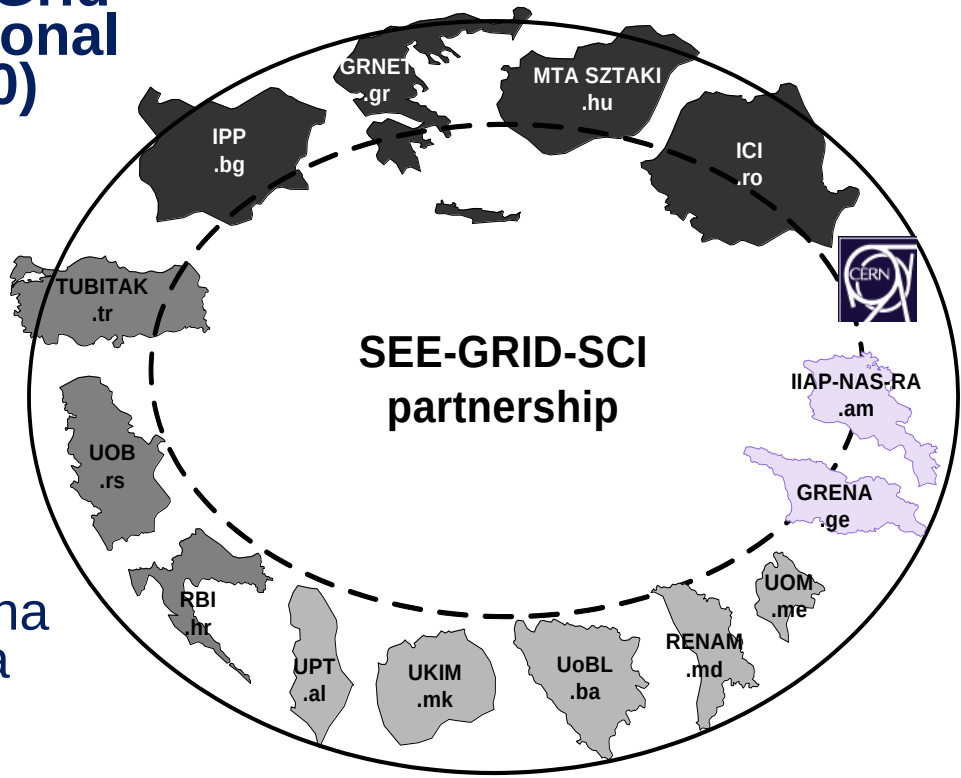
Main Results

- General framework in the following R&D areas: quantum physics, astrophysics, molecular dynamics, 3D periodic artificial microwave structures, IT infrastructure library performance, quantum 3D reactive scattering in the 3-body system, identification and recognition of objects from video images by using digital signal and image processing methods, two-dimensional cellular automata, decision-making and nonlinear boundary parallel algorithms.

International and National Projects: Recent

South Eastern European Grid eInfrastructure for regional eScience (2008-2010)

Contractors	
GRNET	Greece
CERN	Switzerland
SZTAKI	Hungary
IPP-BAS	Bulgaria
ICI	Romania
TUBITAK	Turkey
ASA/INIMA	Albania
UoBL	Bosnia-Herzegovina
UKIM	FYR of Macedonia
UOB	Serbia
UoM	Montenegro
RENAM	Moldova
RBI	Croatia
IIAP-NAS-RA	Armenia
GRENA	Georgia



Third Party / JRU mechanism used associate universities / research centres

International and National Projects: Recent

Development of Armenian-Georgian Grid Infrastructure and applications in the Fields of High Energy Physics, Astrophysics and Quantum Physics (2008-2010)

Participants

- Armenia: Institute for Informatics and Automation Problems NAS RA; Yerevan Physics Institute; Yerevan State University; Byurakan Astrophysical Observatory NAS RA
- Georgia: Georgian Research and Educational Networking Association; Georgian E.Kharadze National Astrophysical Observatory; Ivane Javakhishvili Tbilisi State University

Expected Main Results

- High Energy Physics: The calculation of NNLL QCD corrections for B > Xsγ decay; Monte Carlo production for the HERMES; Determination of the spin structure of nucleon-nucleon interaction; Spin-filtering experiment; Astrophysics: Development of Armenian-Georgian Virtual Observatory; Quantum Physics: High performance computer modeling of quantum optical devices and microstructured Nonlinear Materials

International and National Projects: Recent

State Target Project entitled Deployment of Armenian National Grid Infrastructure (2010-2012)

Participants

- Institute for Informatics and Automation Problems NAS RA
- Institute of Radiophysics & Electronics NAS RA
- Center for Ecological Noosphere Studies NAS RA
- Institute of Geological Sciences NAS RA
- Yerevan Physics Institute
- Yerevan State University
- State Engineering University of Armenia
- Ministry of Natural Protection
- Armenian State Hydrometeorological and Monitoring Service
- Armenian eScience Foundation

International and National Projects: Recent

European Grid Initiative: Integrated Sustainable Pan-European Infrastructure for Researchers in Europe (39 EU countries + CERN) (2010-2014)

Central to this proposal and key to coordinating an Integrated Sustainable Pan-European Infrastructure for Researchers in Europe (InSPIRE) is a new legal organisation EGI.eu which will be the lead partner in the EGI-InSPIRE project. Currently, being established in Amsterdam, EGI.eu‘s focus is coordinating the continued operation and expansion of today‘s production grid infrastructure that supports over 13,000 researchers, many of them already heavy users of the infrastructure, across diverse disciplines such as Earth Science, Astronomy & Astrophysics, Fusion research, Computational Chemistry, Materials Science, Life Sciences and High Energy Physics.

International and National Projects: Recent

High-Performance Computing Infrastructure for South East Europe's Research Communities (14 countries) (2010-2012)

HP-SEE focuses on a number of strategic actions. First, it will link existing and upcoming HPC facilities in the region in a common infrastructure, and provide operational solutions for it. As a complementary action, the project will establish and maintain GEANT link for Caucasus. Second, it will open this HPC infrastructure to a wide range of new user communities, including those of less resourced countries, fostering collaboration and providing advanced capabilities to researchers, with an emphasis on strategic groups in computational physics, chemistry and life sciences. Finally, it will ensure establishment of national HPC initiatives, and act as a SEE bridge for PRACE.

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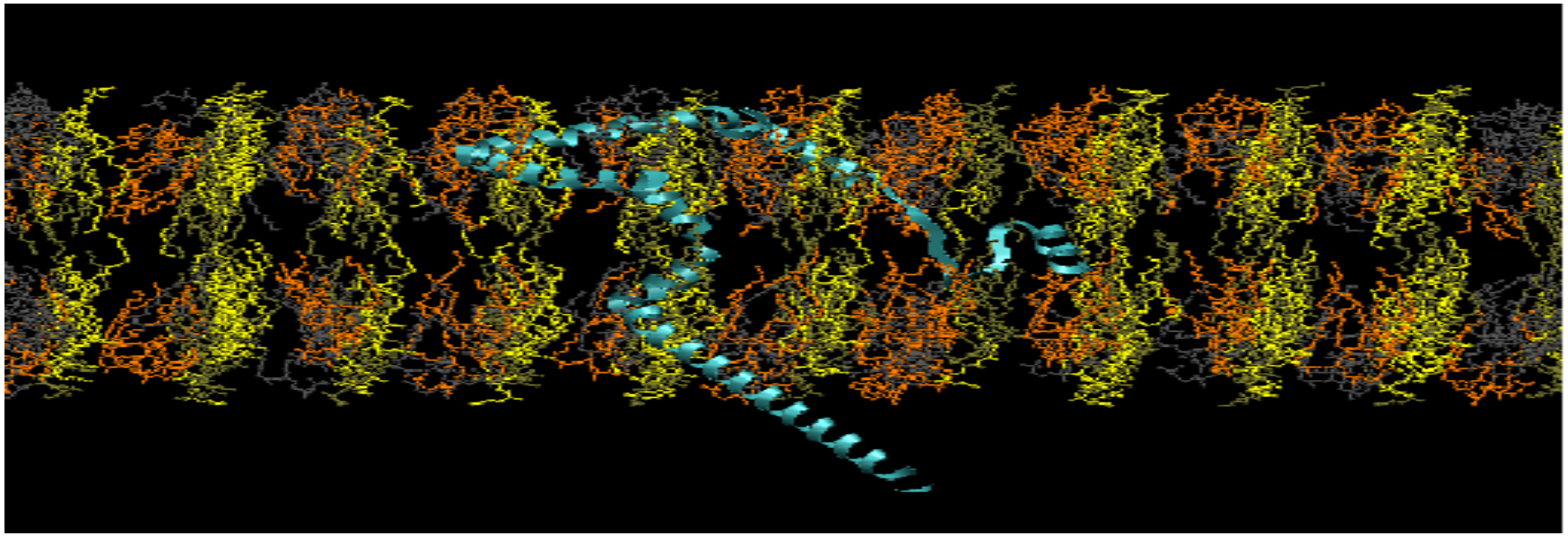
- **Heavy User Communities**

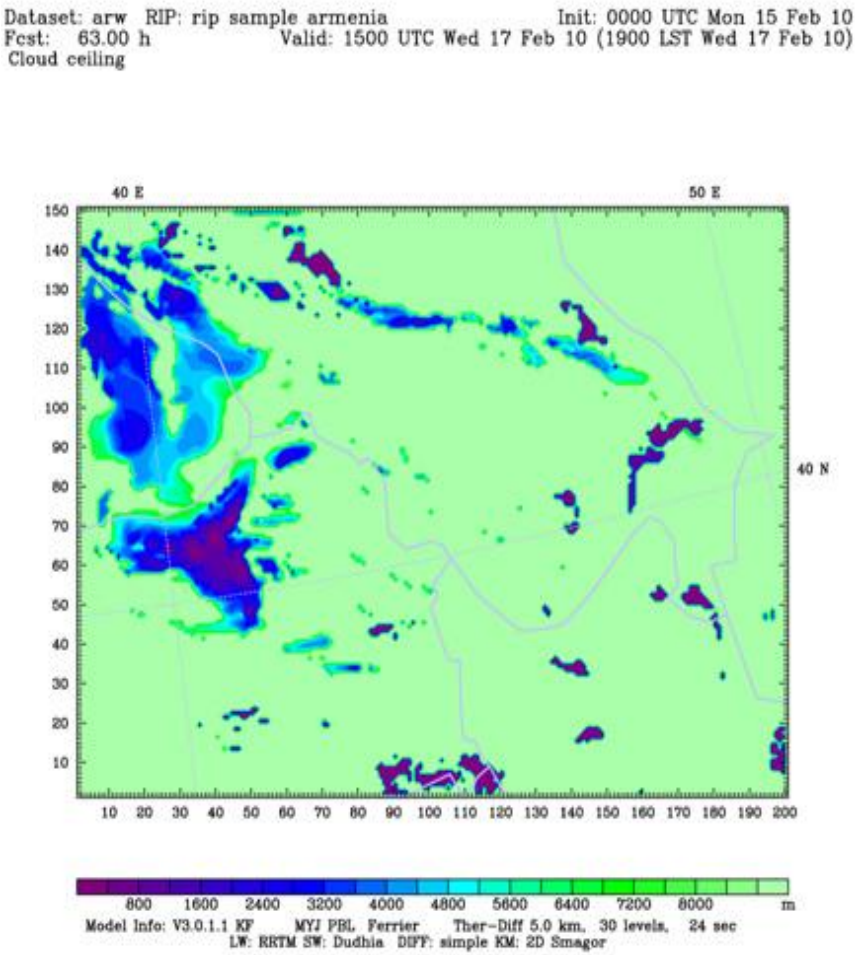
Heavy User Communities: Life Sciences

A series of long simulations have been done including both biological and surfactant systems. Previously, a 150ns of MD simulation of human red blood erythrocyte membrane was carried out and the main structural and dynamical parameters were calculated and compared with existing experimental findings. The heterogeneous erythrocyte membrane model included two types of phospholipids with different hydrocarbon chains,



Heavy User Communities: Numerical Weather Prediction

The Weather Research and Forecasting model implemented and operationally used for the territory of Armenia by Armenian State Hydrometeorological and Monitoring Service. Initial condition data is taken from Meteo (downloaded from National Center for Environmental Prediction) database and the results of calculations are stored in the forecast database.



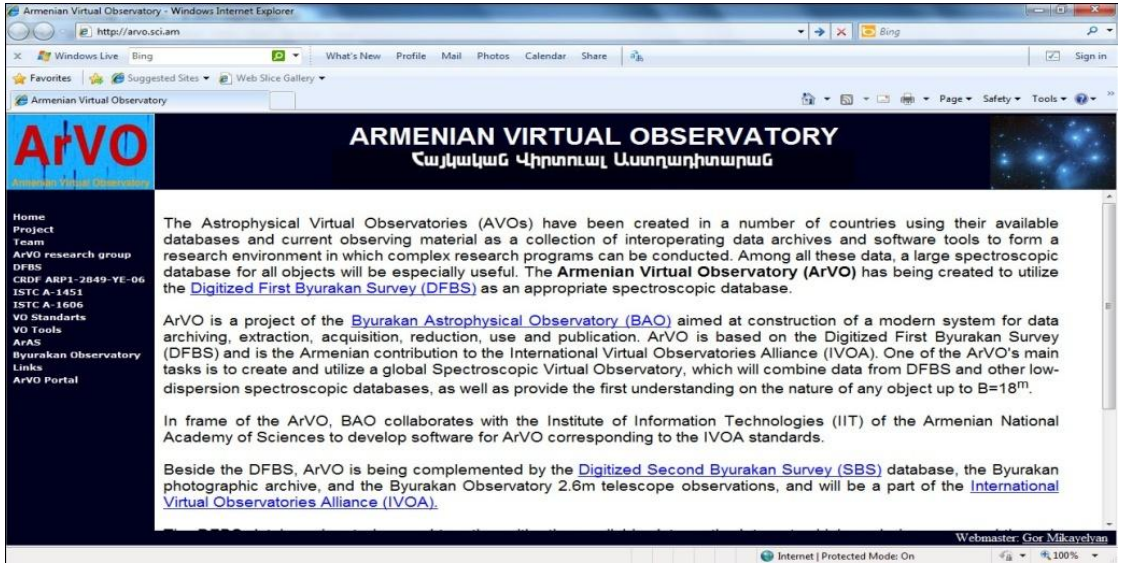
Heavy User Communities: Environmental Protection

The core of the air pollution system is the Air Quality (Community Multiscale Air Quality, CMAQ) modeling system, which has been designed to approach air quality as a whole by including state-of-the-science capabilities for modeling multiple air quality issues, including tropospheric ozone, fine particles, toxics, acid deposition, and visibility degradation.

The first experiments have been done in the Hrazdan region of Armenia.

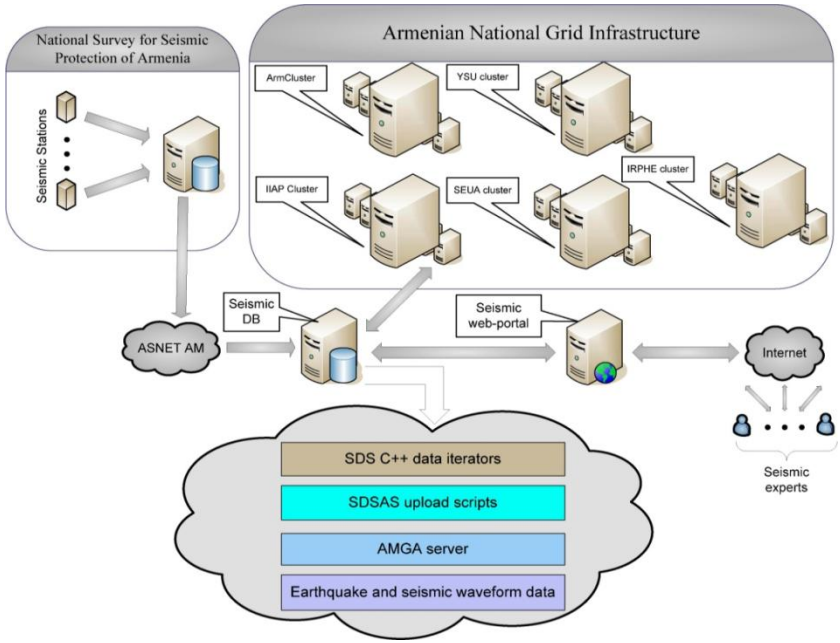
Heavy User Communities: Astrophysics

At present the International Virtual Observatories Alliance unifies 17 national VO projects and serves for coordination of the homogeneity and interoperability of existing astronomical data (images, spectra, catalogs, literature, etc.). The Armenian VO project is being developed since 2005 and is a part of the International Virtual Observatory Alliance.



Heavy User Communities: Seismology

In Armenia the seismological data are collected from about thirty stations and stored at the servers of National Survey for Seismic Protection of Armenia. The seismology platform consists of the seismic data, AMGA Metadata Catalog, programming tools and applications (ELF, SRA, etc.) developed within the EU FP7 SEE GRID SCI Project.



Heavy User Communities: Physics

- Grid infrastructure in the field of quantum information technologies and new nonlinear materials
- Coding of the full chain for the Monte Carlo production for physics analyses of HERMES experiment using
- Implementation of matrix pseudo-random generator and numerical solution of very complicated physics(ongoing)
- The calculation of NNLL QCD corrections for B ->Xs\gamma decay(ongoing)
- Extend of NNLL QCD corrections calculation methods using parallel computing and GRID technology
- Accelerator physics, beam dynamics special studies - Accelerators design
- Accelerator physics, beam dynamics special studies - FEL radiation simulations

Heavy User Communities: Mathematics

Computational cluster “Armcluster”

Software environment

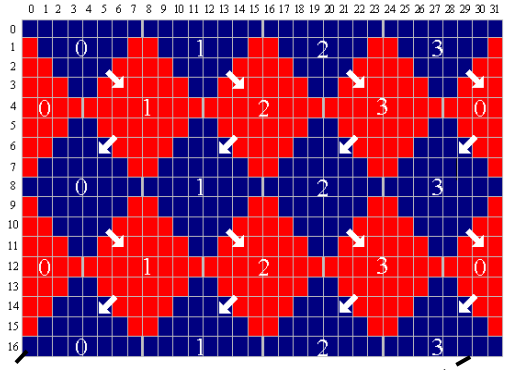
Manager programs

Application programs

Existent software packages

Developed software packages

SAS



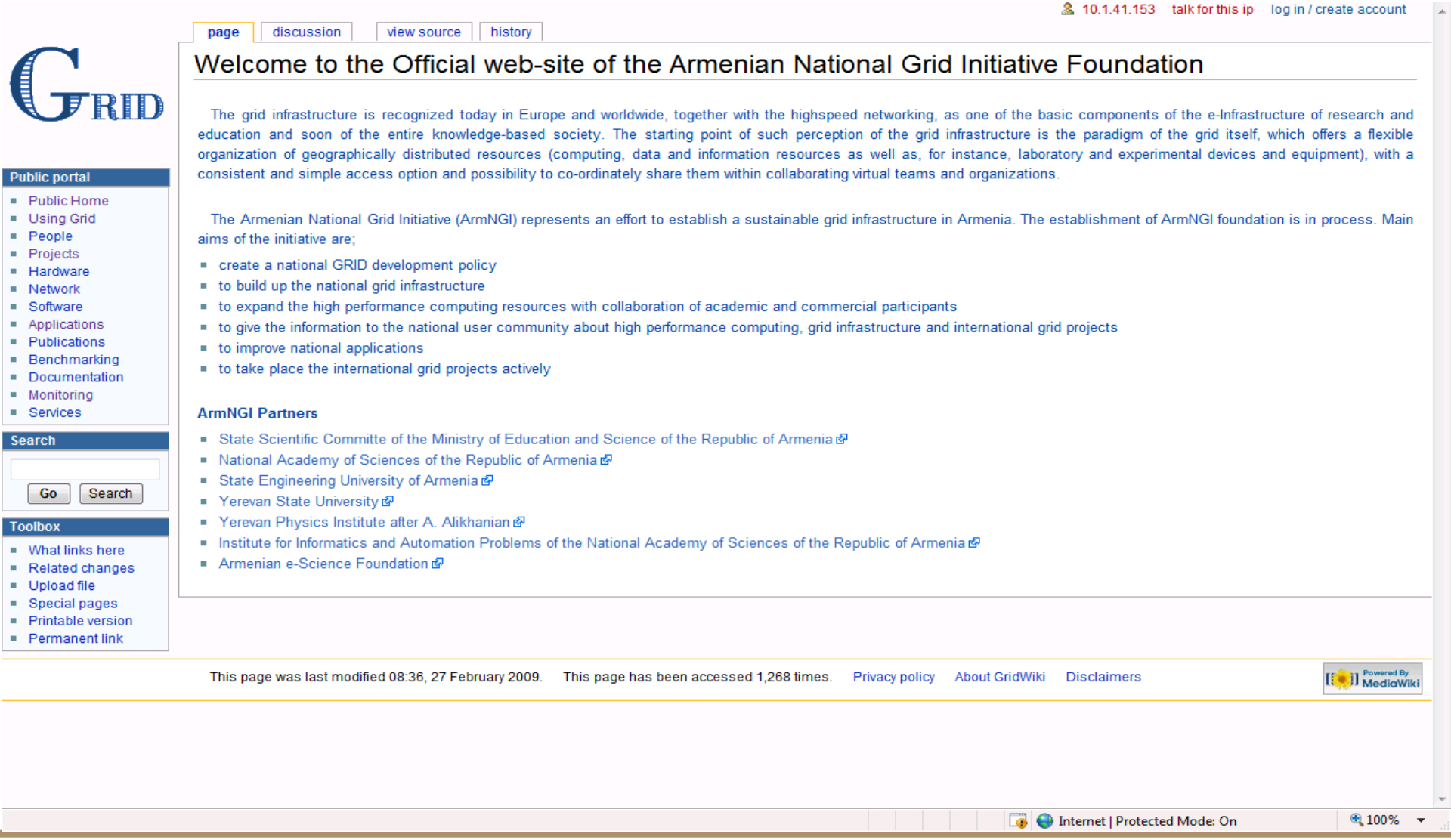
Editor → **Parser** → **Planner** → **Code Generator**

SAD **PM**

SAD – description of one (two)-dimensional systolic array

PM – cluster based programming module

Grid Activities in Armenia: More Information (http://www.grid.am)



Special Thanks to

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