GRID и компьютерные вычисления на LHC

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Концепция Грид

«Грид - это система, которая:

· координирует использование ресурсов при отсутствии централизованного управления этими ресурсами

· использует стандартные, открытые, универсальные протоколы и интерфейсы.

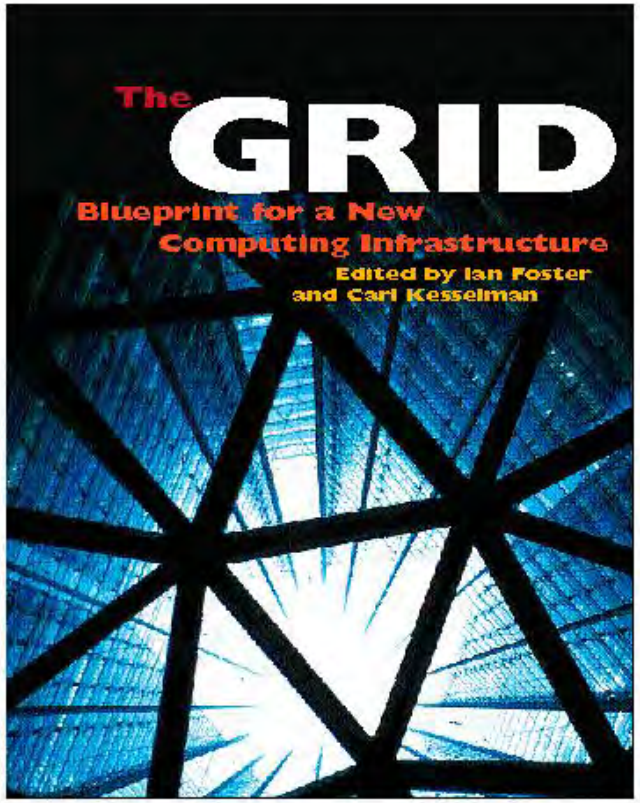
· обеспечивает высококачественное обслуживание»

(Ian Foster: "What is the grid? ", 2002 г.)

Создание компьютерной инфраструктуры нового типа, обеспечивающей глобальную интеграцию информационных и вычислительных ресурсов на основе управляющего и оптимизирующего программного обеспечения (middleware) нового поколения.

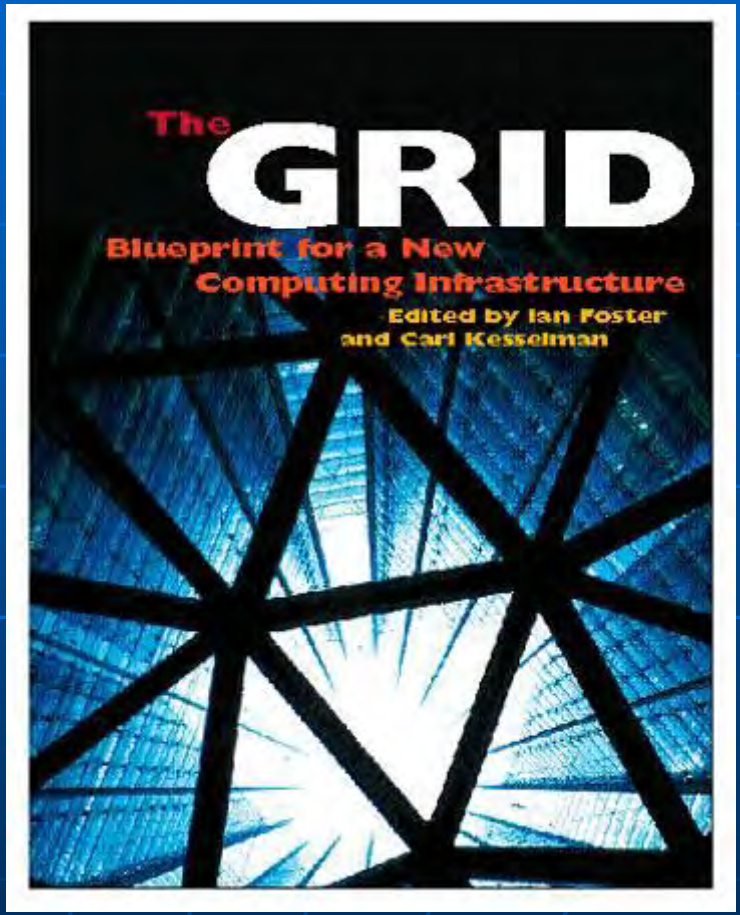
Междисциплинарный характер грид: развиваемые технологии применяются в физике высоких энергий, космофизике, микробиологии, экологии, метеорологии, различных инженерных и бизнес приложениях.

Виртуальные организации (VO)



Five Emerging Models of Networked Computing From *The Grid*

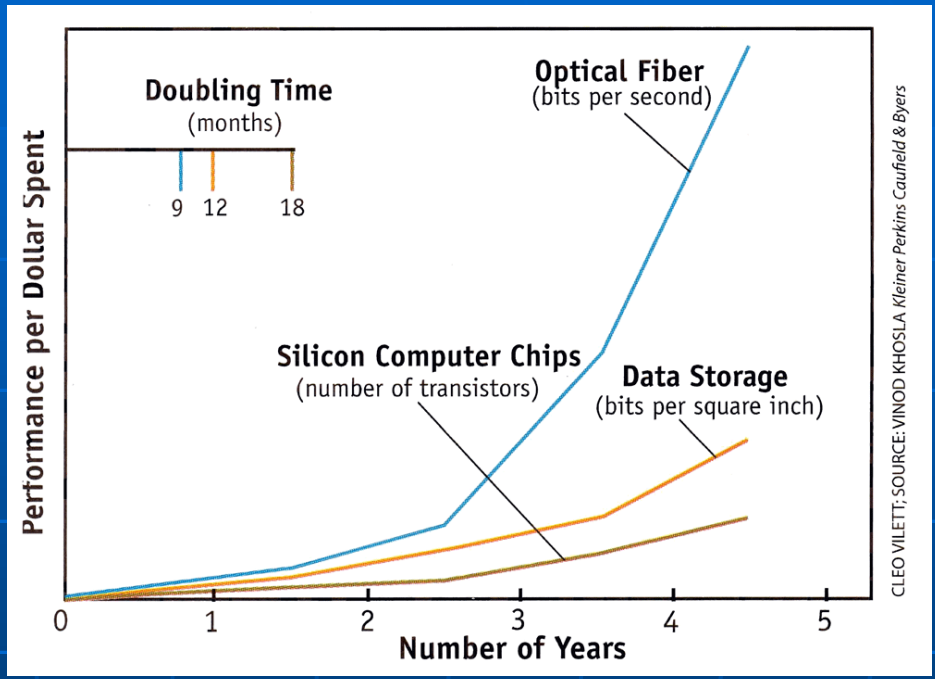
- **Distributed Computing**
  - **|| synchronous processing**
- **High-Throughput Computing**
  - **|| asynchronous processing**
- **On-Demand Computing**
  - **|| dynamic resources**
- **Data-Intensive Computing**
  - **|| databases**
- **Collaborative Computing**
  - **|| scientists**



Ian Foster and Carl Kesselman, editors, "The Grid: Blueprint for a New Computing Infrastructure," Morgan Kaufmann, 1999, http://www.mkp.com/grids

Grid is a result of IT progress

Network vs. computer performance:	• Computer speed doubles every 18 months • Network speed doubles every **9** months
1986 to 2000:	• Computers: 500 times faster • Networks: 340000 times faster
2001 to 2010 (projected):	• Computers: 60 times faster • Networks: 4000 times faster



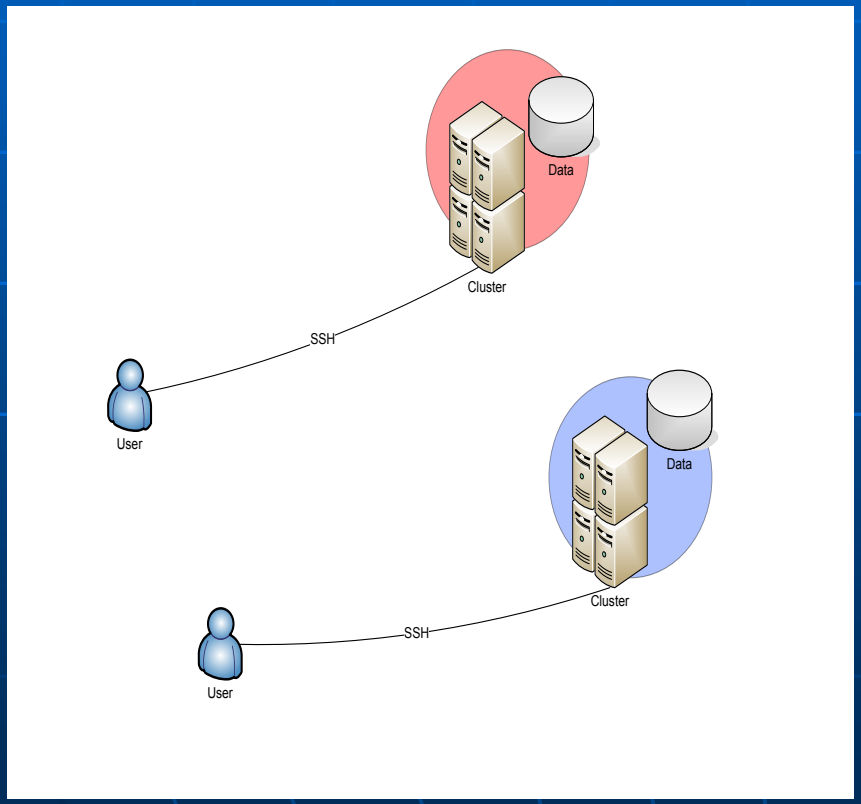
Excellent wide area networks provide for a distributed supercomputer – ***the Grid***

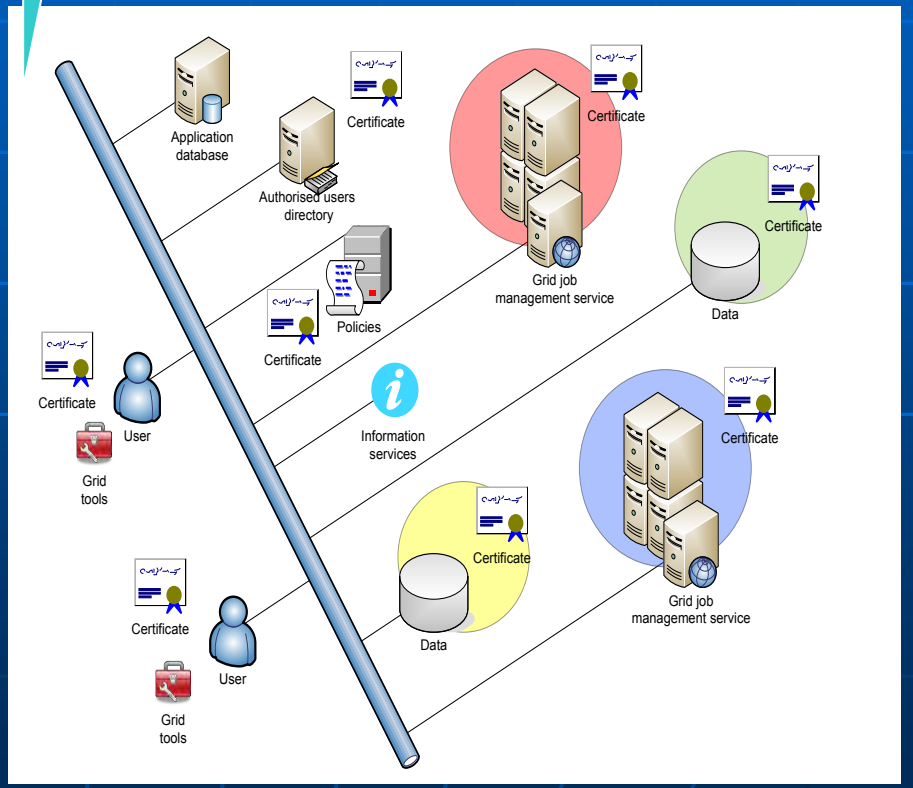
"Operating system" of such a computer is ***Grid middleware***

Graph from "The Triumph of the Light", G. Stix, Sci.Am. January 2001

From the conventional HPC…

To the Grid





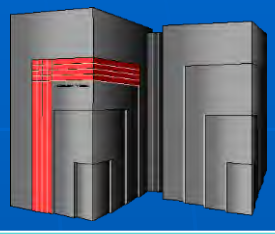
Грид - это средство для совместного использования вычислительных мощностей и хранилищ данных посредством интернета

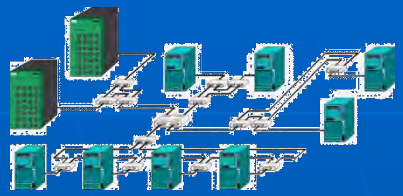
Мобильный доступ

Рабочие станции

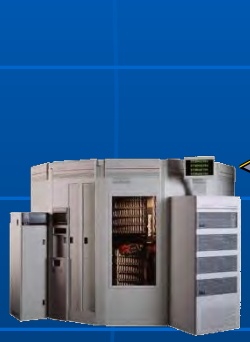
Визуализация

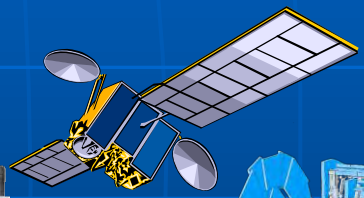
ПРОМЕЖУТОЧНОЕ ПРОГРАММНОЕ ОБЕСПЕЧЕНИЕ ГРИД

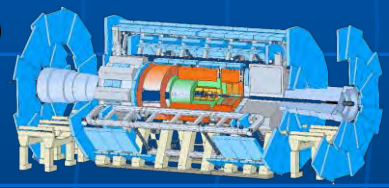




Суперкомпьютеры, ПК- кластеры



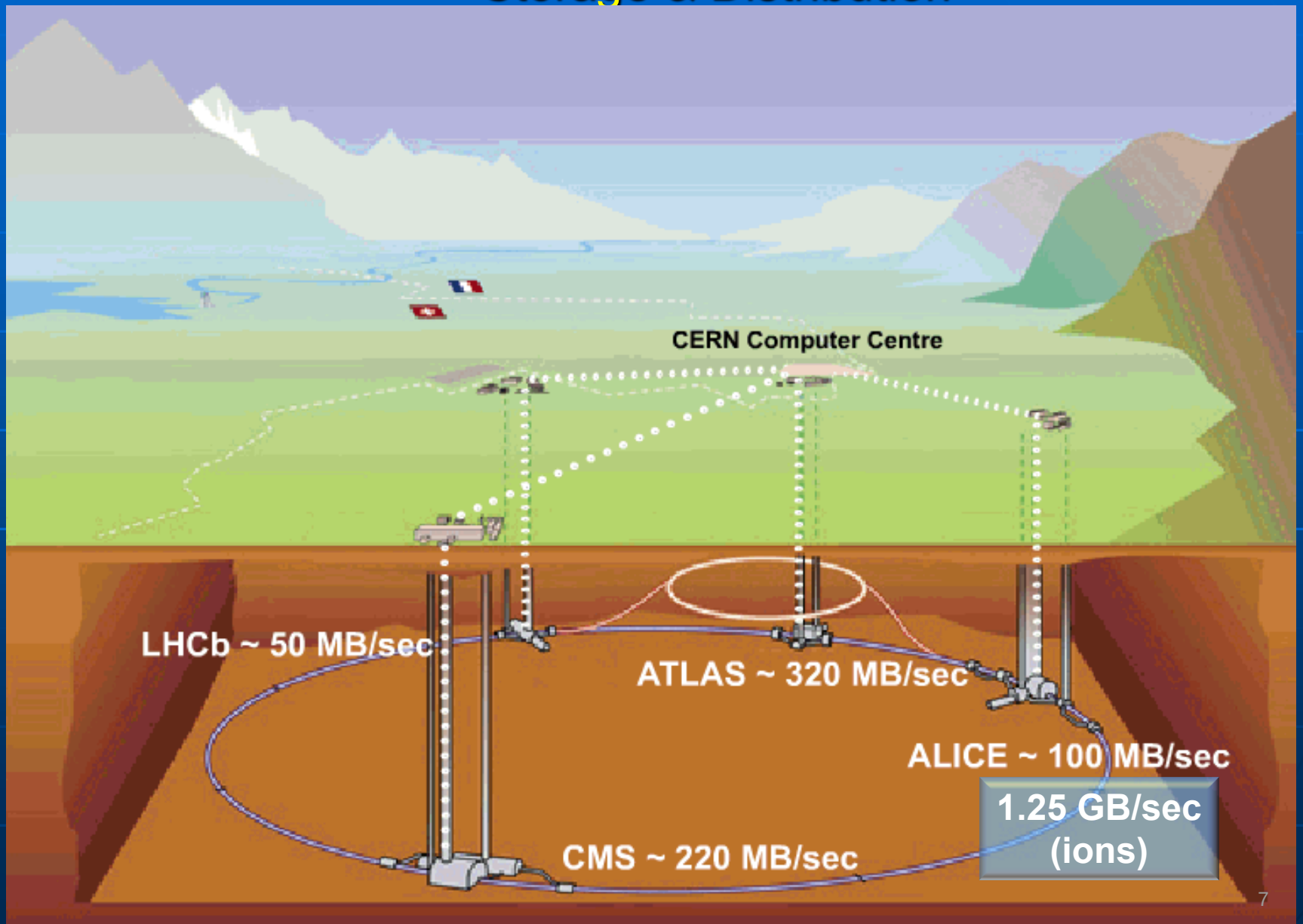




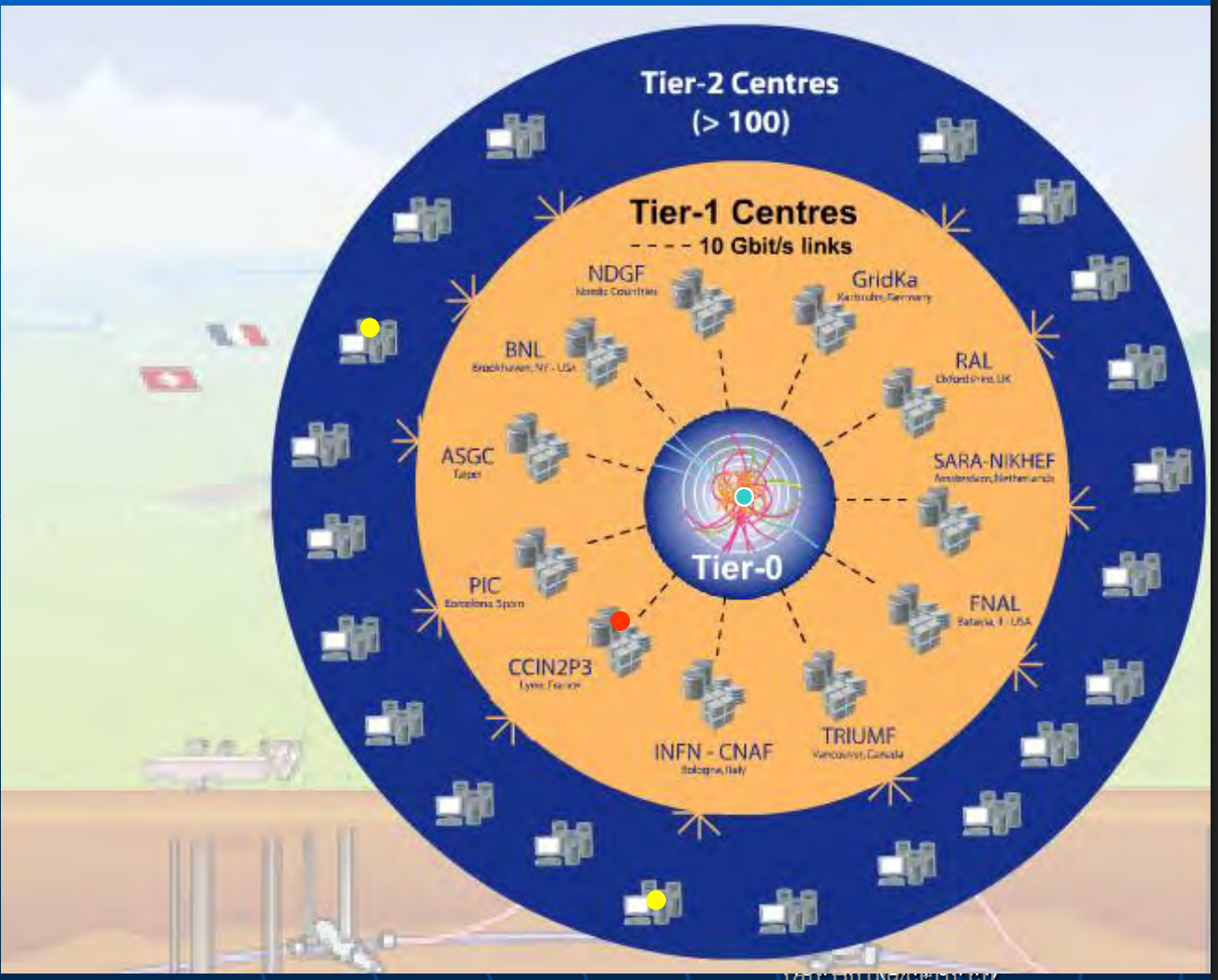
Массовая память, сенсоры, эксперименты

Интернет, сети

Tier 0 at CERN: Acquisition, First pass reconstruction, Storage & Distribution



Tier Structure of GRID Distributed Computing: Tier-0/Tier-1/Tier-2/Tier-3



Tier-0 (CERN):

- accepts data from the CMS Online Data Acquisition and Trigger System
- archives RAW data
- the first pass of reconstruction and performs Prompt Calibration
- data distribution to Tier-1

Tier-1 (11 centers):

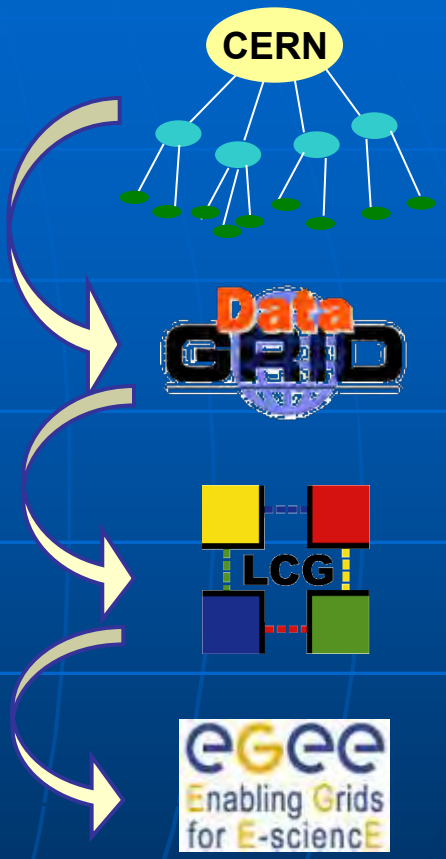
- receives a data from the Tier-0
- data processing (re-reconstruction, skimming , calibration etc)
- distributes data and MC to the other Tier-1 and Tier-2
- secure storage and redistribution for data and MC

Tier-2 (>200 centers):

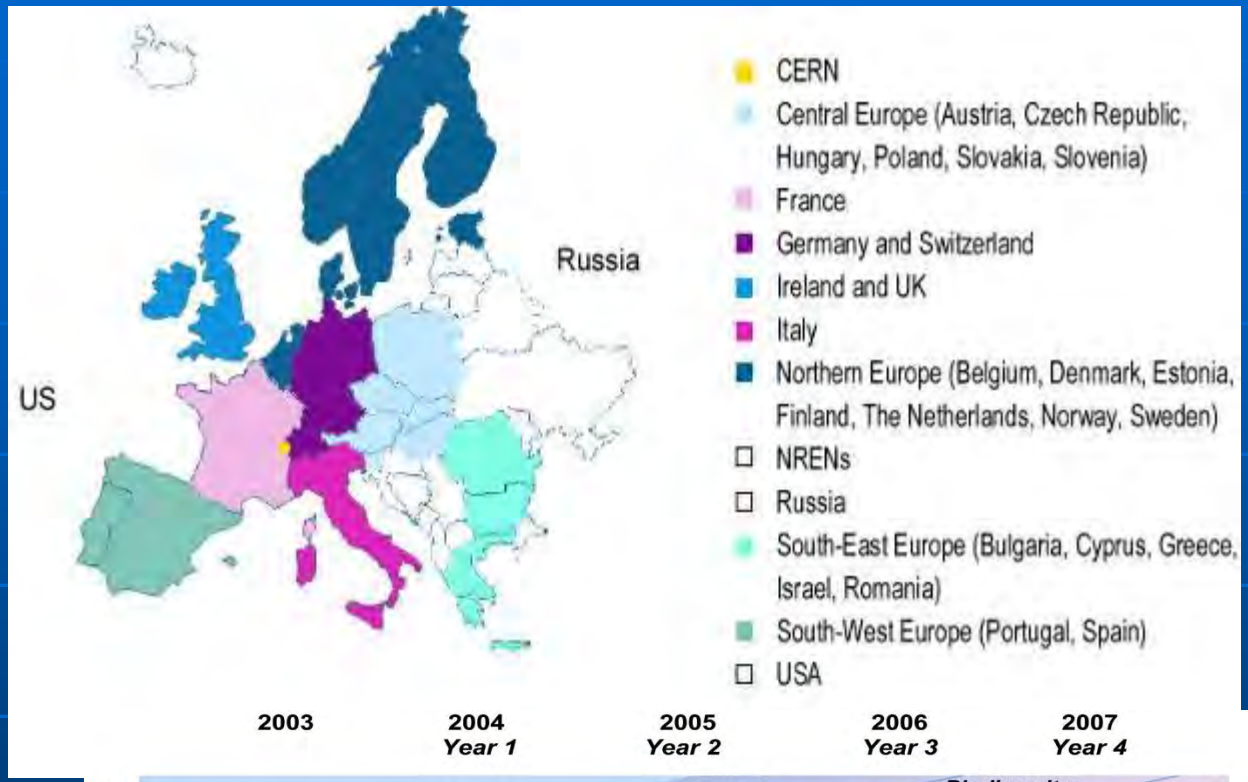
- simulation
- user physics analysis

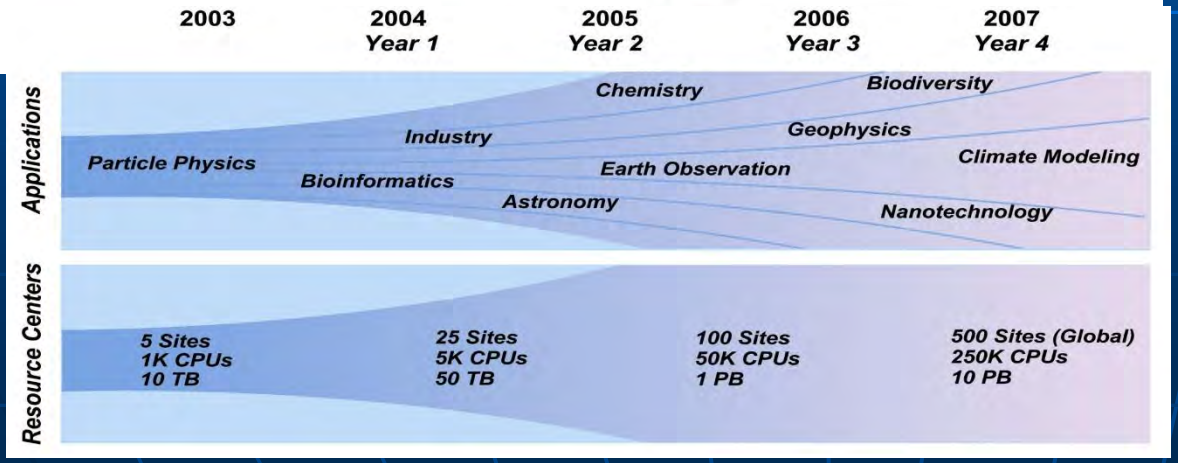
Some history

- 1999 – Monarc Project
  - Early discussions on how to organise distributed computing for LHC
- 2001-2003 - EU DataGrid project
  - middleware & testbed for an operational grid
- 2002-2005 – LHC Computing Grid – LCG
  - deploying the results of DataGrid to provide a production facility for LHC experiments
- 2004-2006 – EU EGEE project phase 1
  - starts from the LCG grid
  - shared production infrastructure
  - expanding to other communities and sciences
- 2006-2008 – EU EGEE-II
  - Building on phase 1
  - Expanding applications and communities …
- 2008-2010 – EU EGEE-III
- 2010-2012 - EGI-InSPIRE



EGEE (Enabling Grids for E-sciencE)



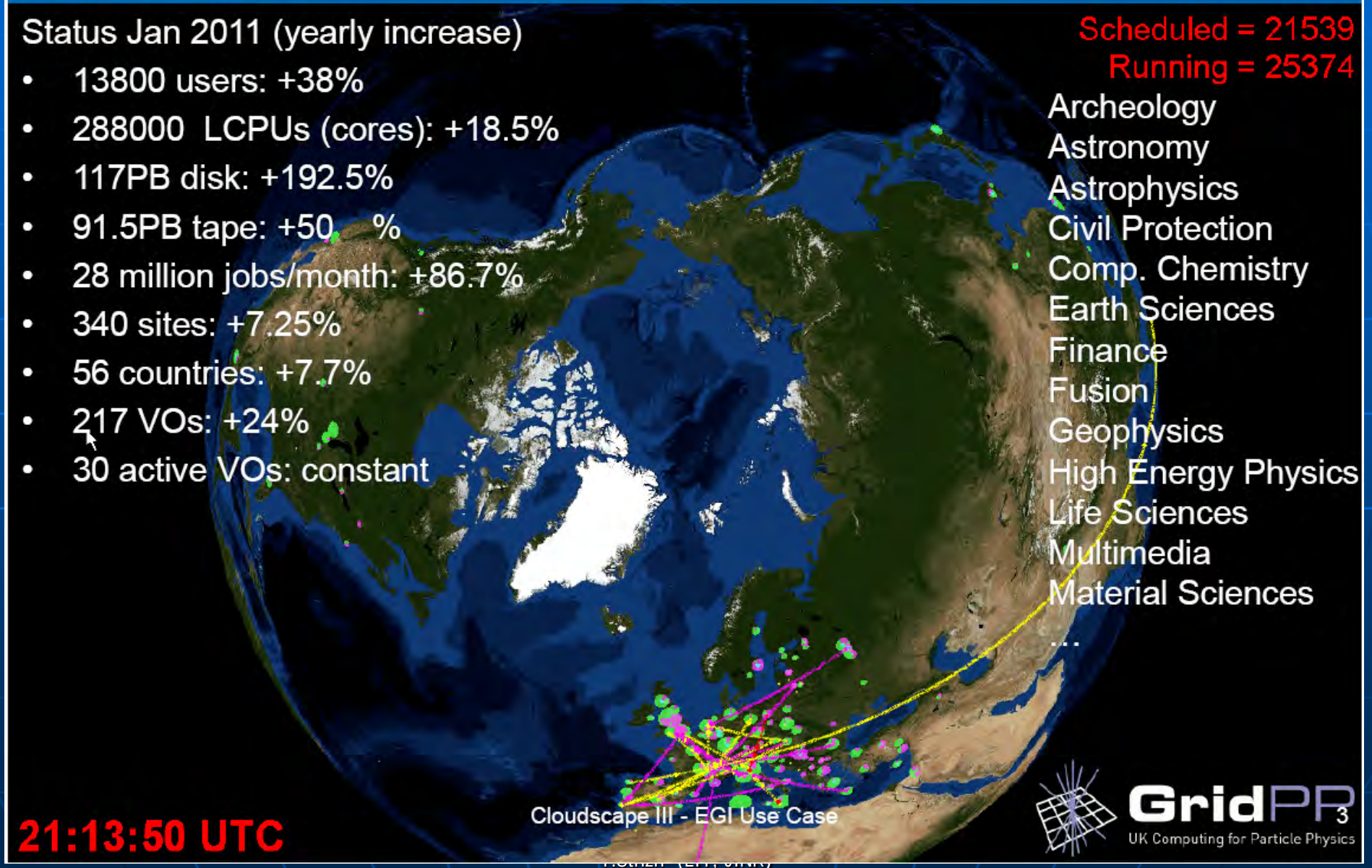


The aim of the project is to create a global Pan-European computing infrastructure of a Grid type.

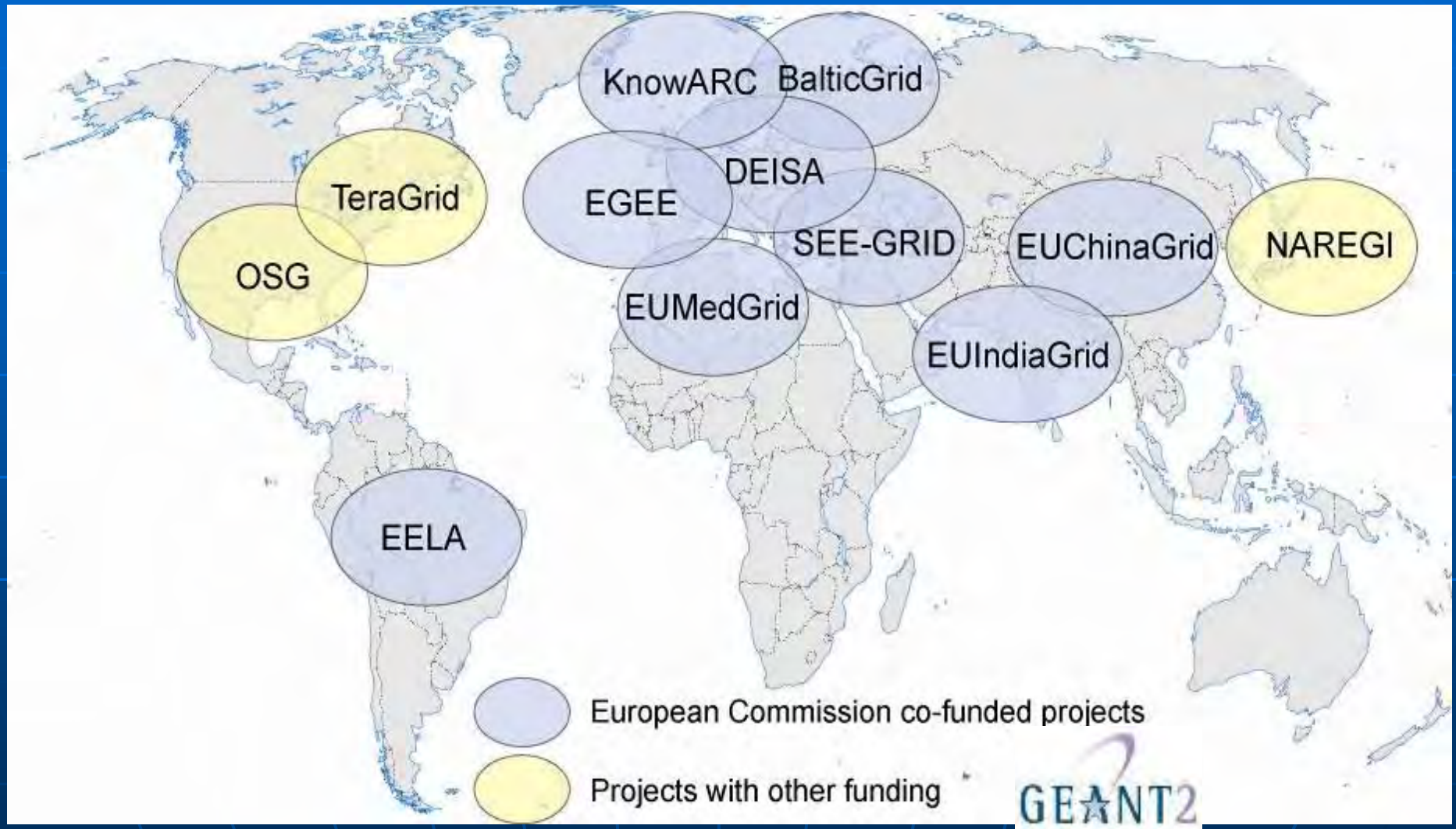
- Integrate regional Grid efforts
- Represent leading grid activities in Europe

10 Federations,
27 Countries,
70 Organizations

European Grid Infrastructure



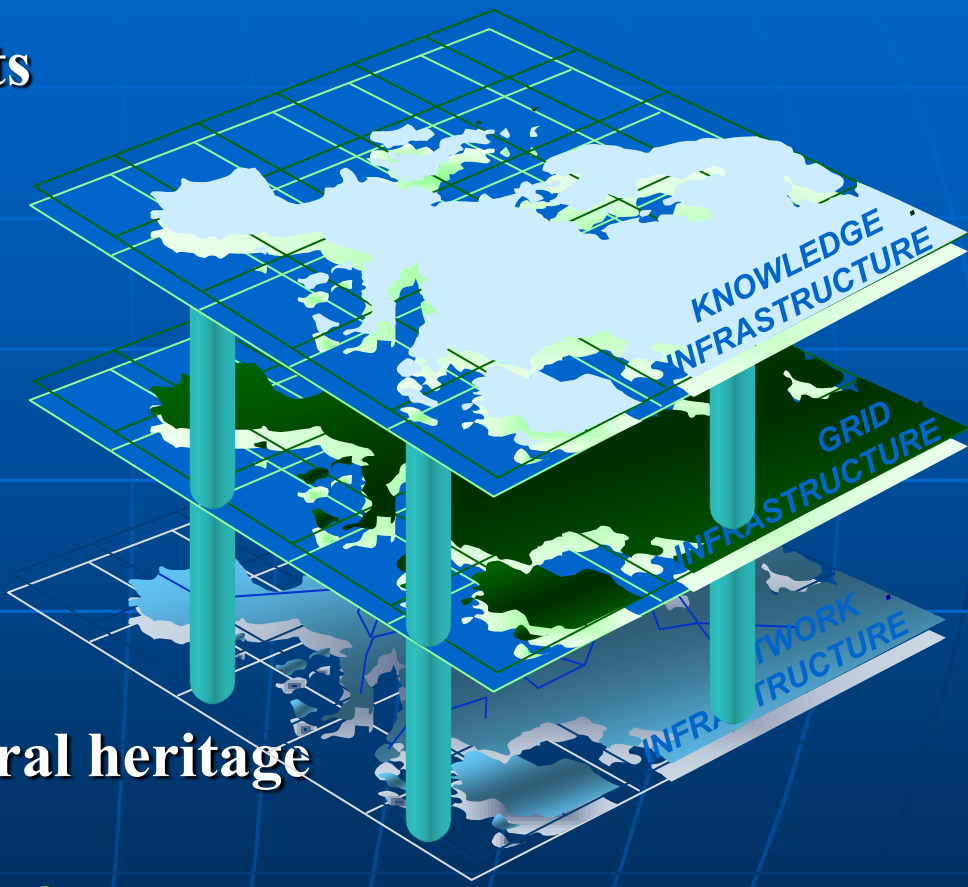
Collaborating e-Infrastructures



Potential for linking ~90 countries by 2010

The Future of Grids

- From e-Infrastructures to Knowledge Infrastructures
- Network infrastructure connects computing and data resources and allows their seamless usage via Grid infrastructures
- Federated resources and new technologies enable new application fields:
  - Distributed digital libraries
  - Distributed data mining
  - Digital preservation of cultural heritage
  - Data curation



→ Knowledge Infrastructure

Major Opportunity for Academic and Businesses alike

Grids, clouds, supercomputers..

Grids
- Collaborative environment
- Distributed resources (political/sociological)
- Commodity hardware (also supercomputers)
- (HEP) data management
- Complex interfaces (bug not feature)

Supercomputers
- Expensive
- Low latency interconnects
- Applications peer reviewed
- Parallel/coupled applications
- Traditional interfaces (login)
- Also SC grids (DEISA, Teragrid)

Many different problems: Amenable to different solutions

No right answer

Clouds
- Proprietary (implement
- Economies of scale in m
- Commodity hardware
- Virtualisation for service provision and encapsulating application environment
- Details of physical resources hidden
- Simple interfaces (too simple?)

mputing
nism to access

- Difficult if (much) data involved
- Control of environment ➔ check
- Community building – people involved in Science
- Potential for huge amounts of real work

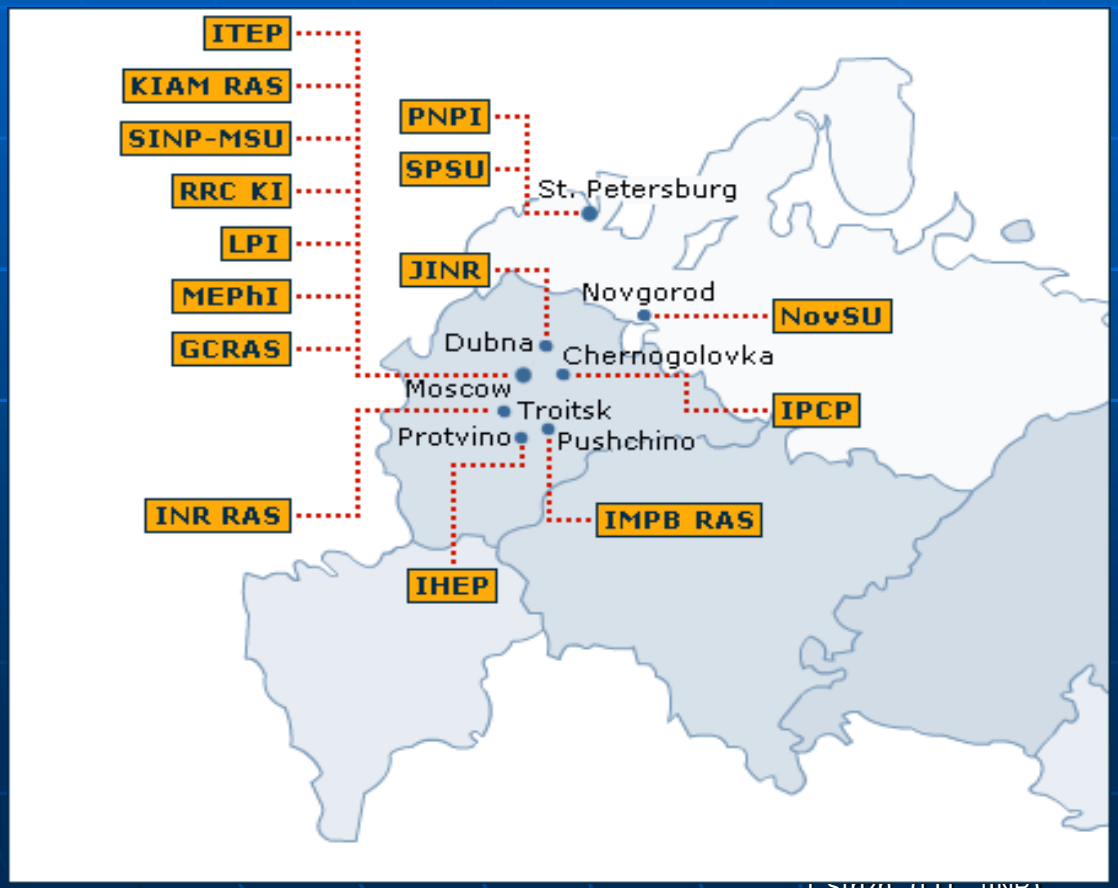
Концепция «Облачных вычислений»

- Все есть сервис (XaaS)
  - AaaS: приложения как сервис
  - PaaS: платформа как сервис
  - SaaS: программное обеспечение как сервис
  - DaaS: данные как сервис
  - IaaS: инфраструктура как сервис
  - HaaS: оборудование как сервис

- Воплощение давней мечты о компьютерном обслуживании на уровне обычной коммунальной услуги:
  - масштабируемость
  - оплата по реальному использованию (pay-as-you-go)

Russian Data Intensive Grid infrastructure (RDIG)

The Russian consortium RDIG (Russian Data Intensive Grid), was set up in September 2003 as a national federation in the EGEE project. Now the RDIG infrastructure comprises 17 Resource Centers with > 20000 kSI2K CPU and > 4500 TB of disc storage.

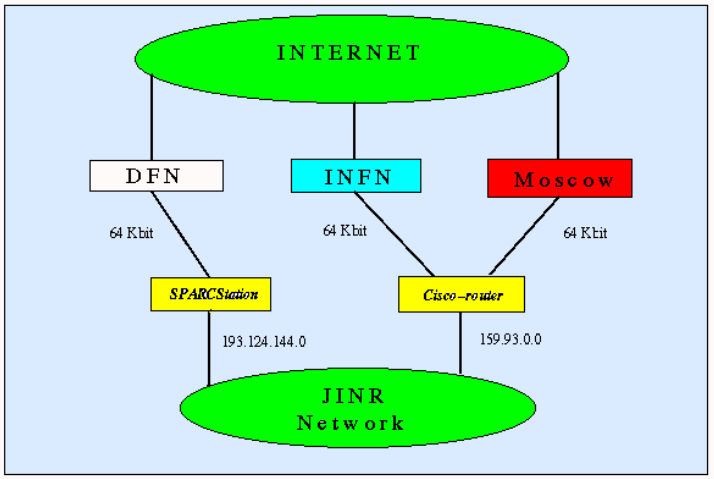


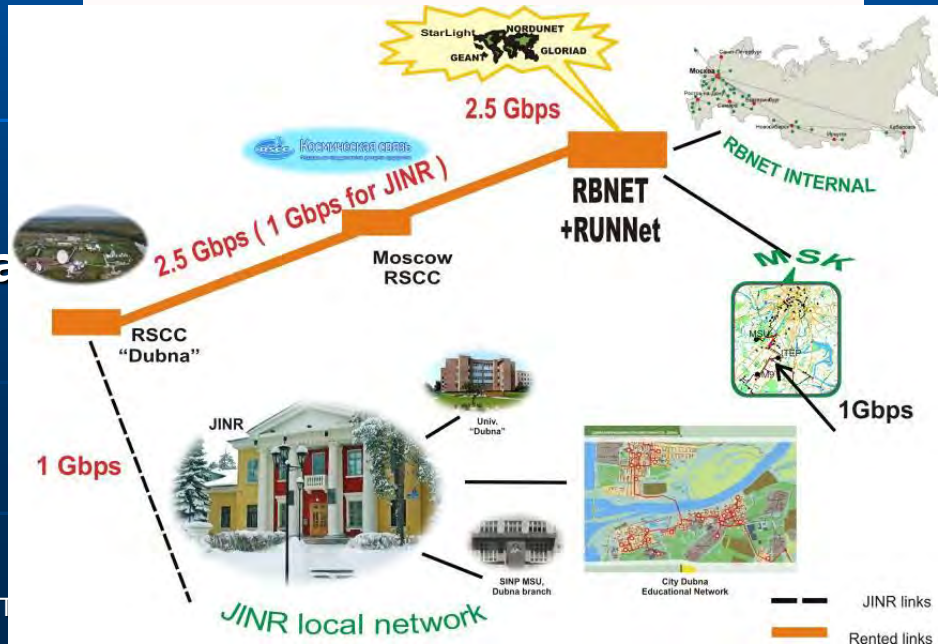
RDIG Resource Centres:

- ITEP
- JINR-LCG2 (Dubna)
- RRC-KI
- RU-Moscow-KIAM
- RU-Phys-SPbSU
- RU-Protvino-IHEP
- RU-SPbSU
- Ru-Troitsk-INR
- ru-IMPB-LCG2
- ru-Moscow-FIAN
- ru-Moscow-MEPHI
- ru-PNPI-LCG2 (Gatchina)
- ru-Moscow-SINP
- Kharkov-KIPT (UA)
- BY-NCPHEP (Minsk)
- UA-KNU
- UA-BITP

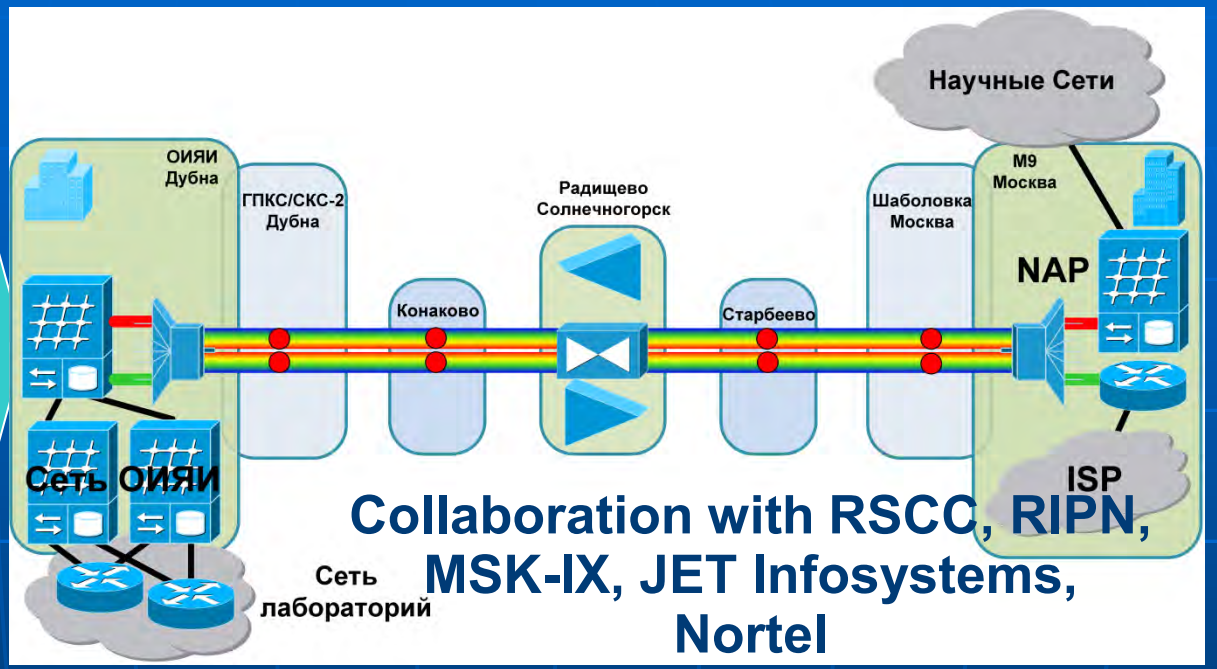
Этапы развития внешних коммуникаций ОИЯИ

- **1992 – 64 Кбит/с спутниковый канал связи с HEPNET в Италии**
- **1994 – 64 Кбит/с спутниковый канал связи с DFN в Германии**
- **1995 – 128 Кбит/с наземный канал связи INTERNET в Москве**
- **1997 – 2 Мбит/с оптический канал связи ОИЯИ-ЦКС «Дубна»-Шаболовка-М9. Узел сети RBNet в Дубне**
- **2001 – реализация проекта ATM канала связи Дубна-Москва емкостью 622 Мбит/с (155 Мбит/с для ОИЯИ)**
- **2002 – 128 Кбит/с спутниковый канал связи Дубна-Алушта**
- **2005 – реализация проекта канала связи Дубна-Москва на основе технологии SDH емкостью 2.48 Гбит/с (1 Гбит/с для ОИЯИ)**
- **2007- 2008 – проработка проекта канала связи Москва-Дубна на базе технологии DWDM**

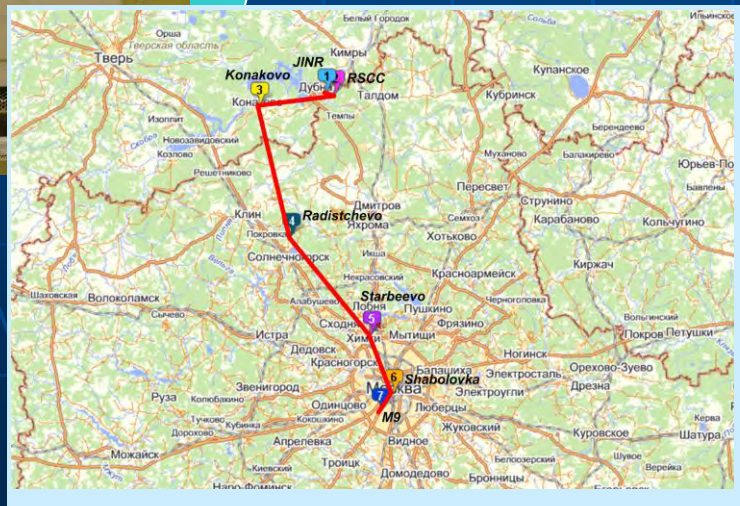




JINR - Moscow 20 Gbps telecommunication channel



Collaboration with RSCC, RIPN, MSK-IX, JET Infosystems, Nortel



MSK IX Московский Internet Exchange

Jet Infosystems

RSCC Russian Satellite Communications Company
Federal State Unitary Enterprise

RIPN Russian Institute for Public Networks

LIT, JINR)

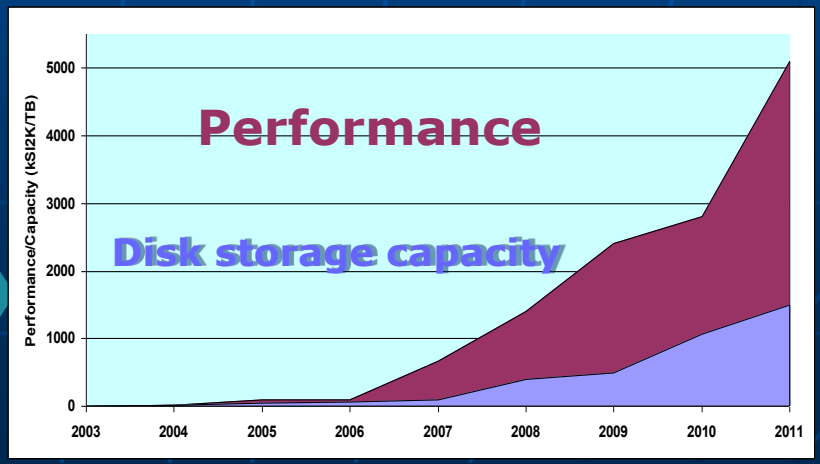
JINR Tier2 Center

CPU: 2500 Core
Total performance 6000 kSI2K
Disk storage capacity 1800 TB

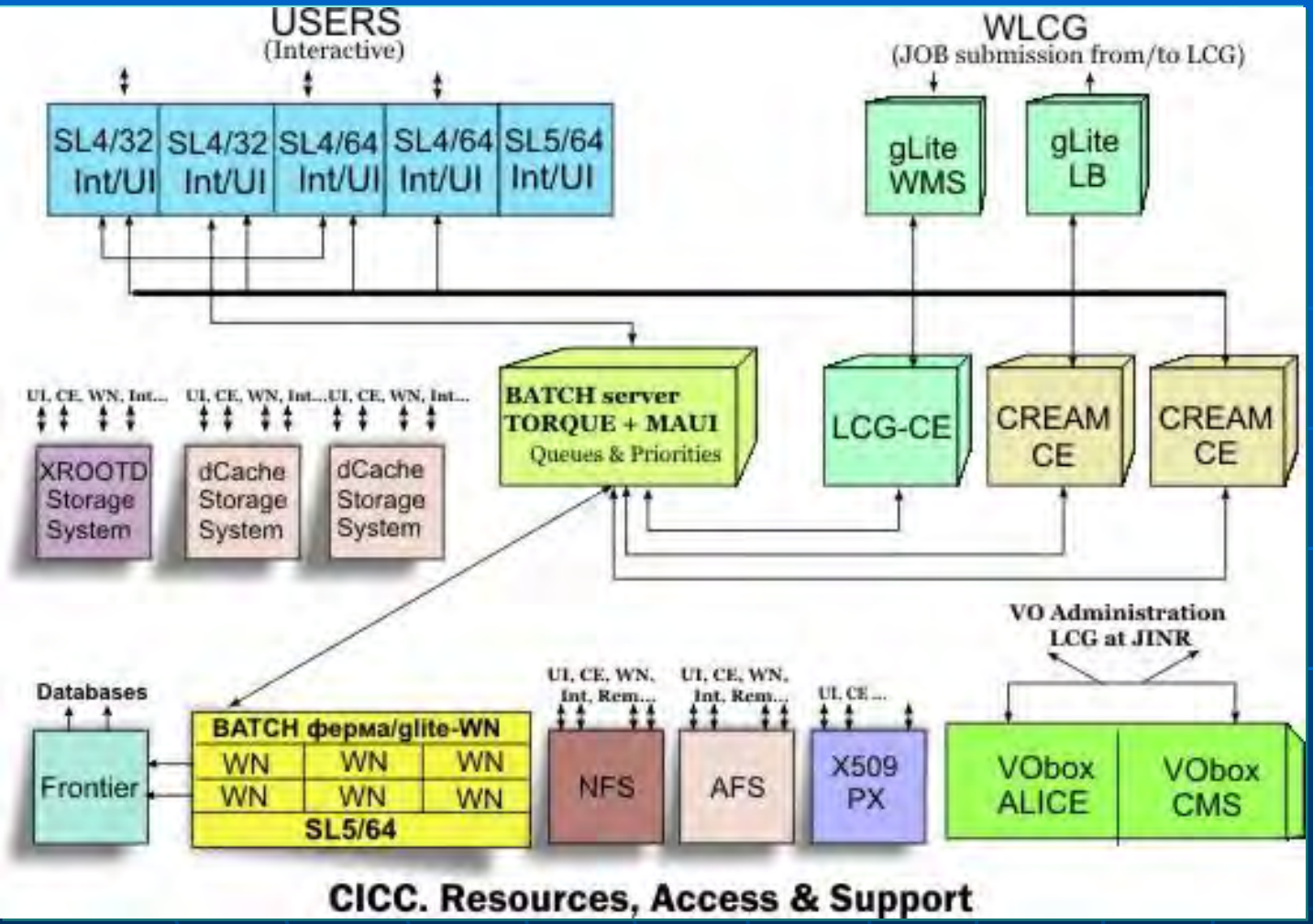
More than **5,3 million tasks** were executed during the year of 2011

Availability and Reliability = 99%

Growth of the JINR Tier2 resources in 2003 - 2011



Support of VOs and experiments

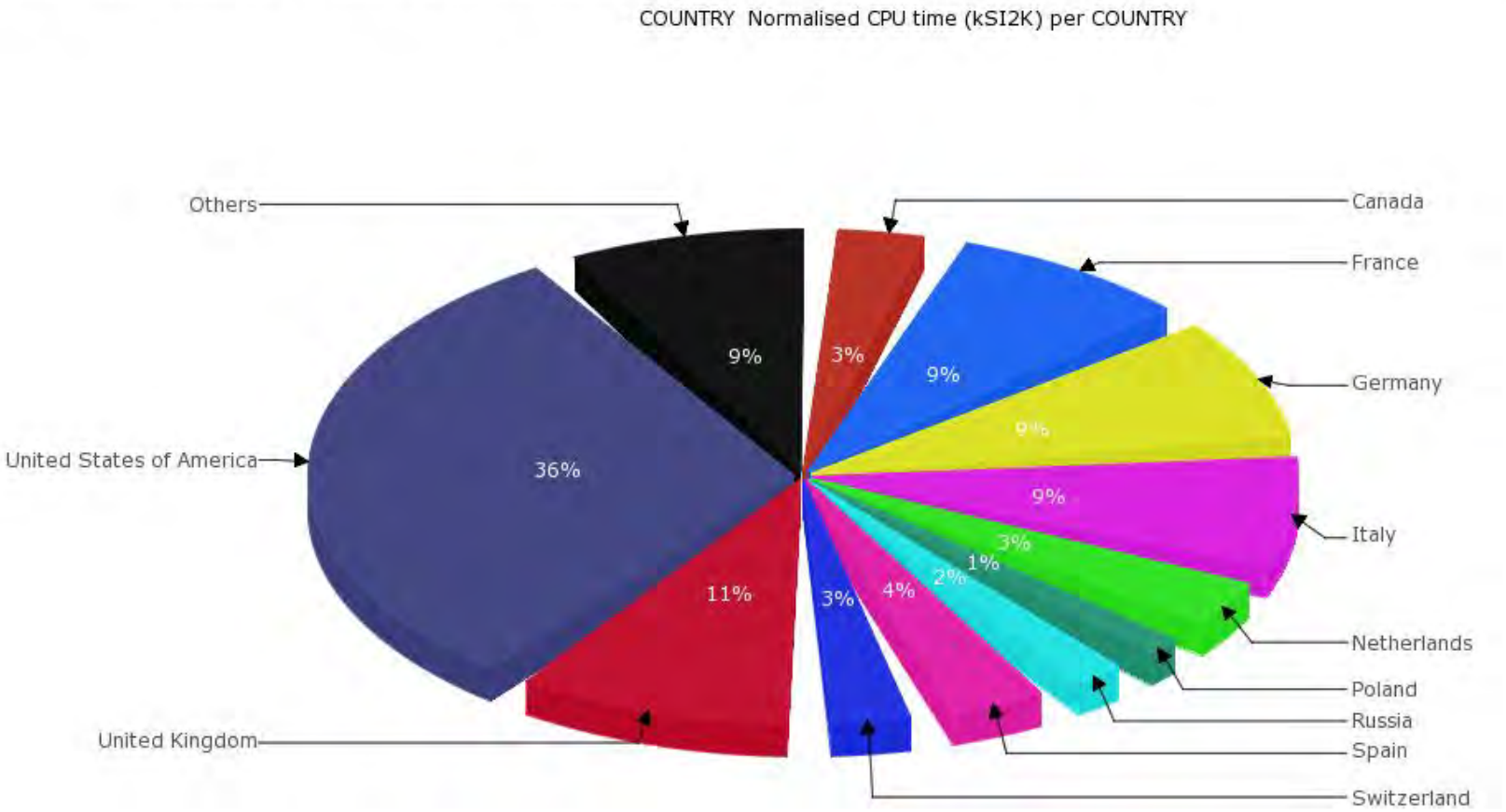


Now CICC JINR as a grid-site of the global grid infrastructure supports computations of 10 Virtual Organizations (alice, atlas, biomed, cms, dteam, fusion, hone, lhcb, rgstest and ops), and also gives a possibility of using the grid-resources for the CBM and PANDA experiments.

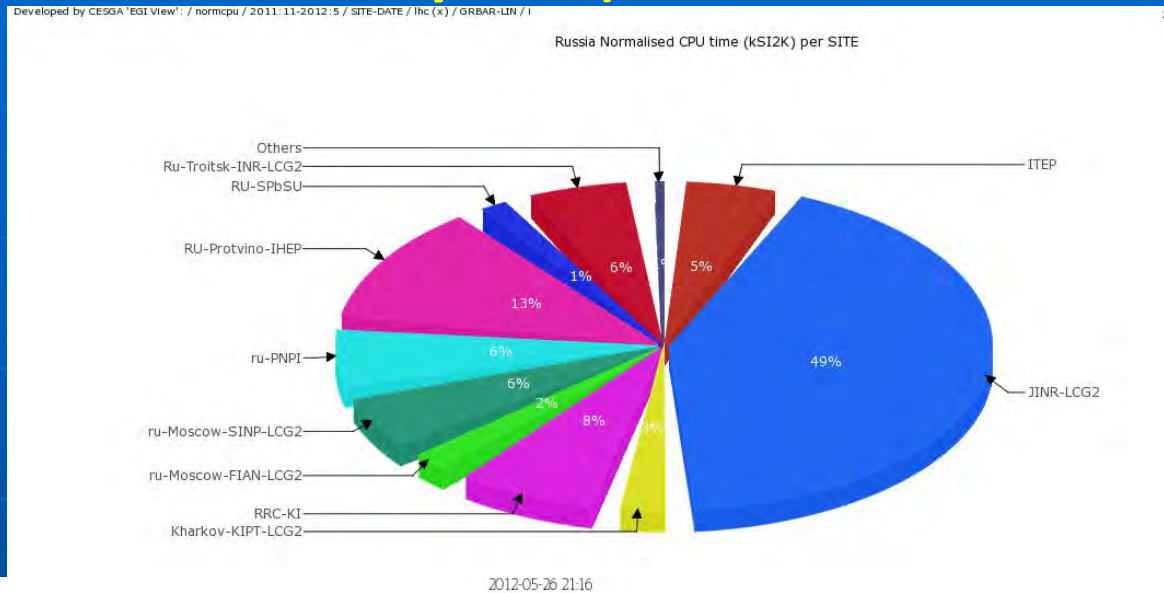
Country Normalized CPU time per Country LHC VO (November 2011 - May 2012)

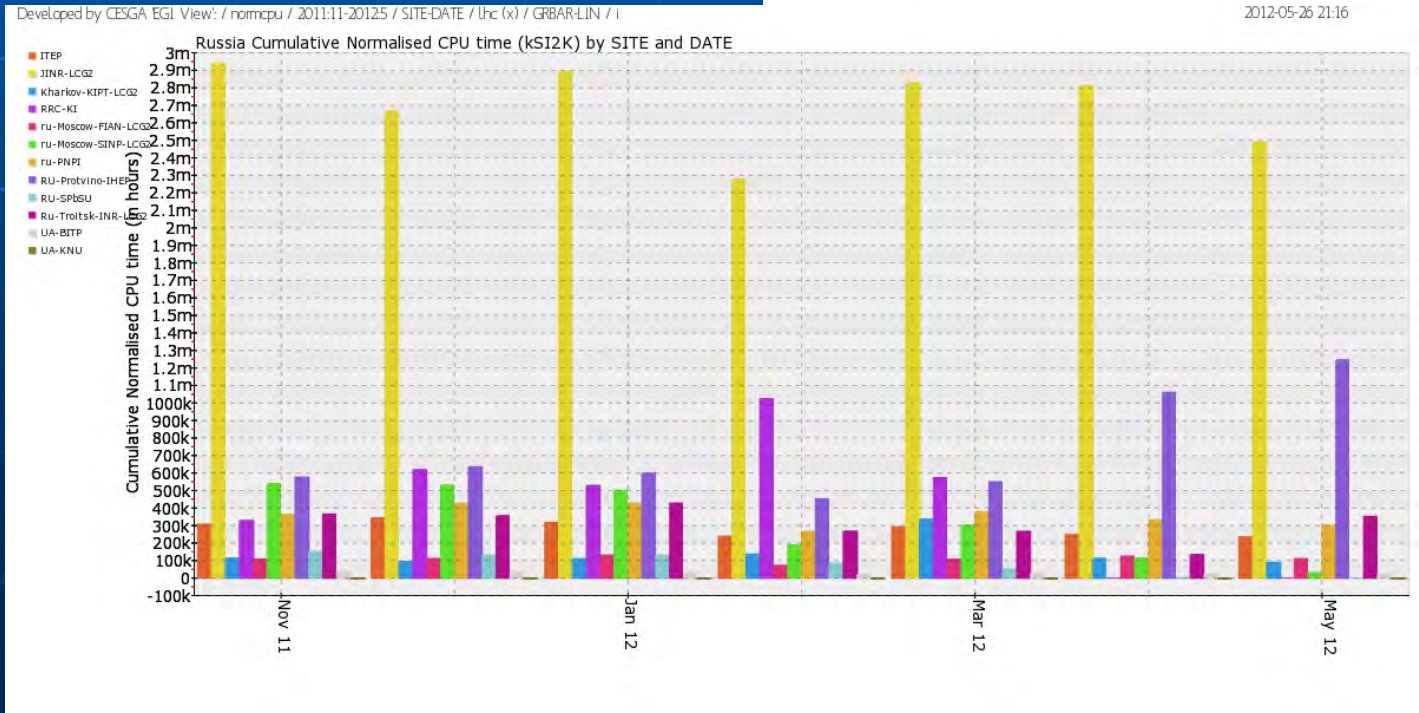
eveloped by CESGA 'EGI View' : / normcpu / 2011:11-2012:5 / COUNTRY-VO / lhc (x) / GRBAR-LIN / l

2012-05

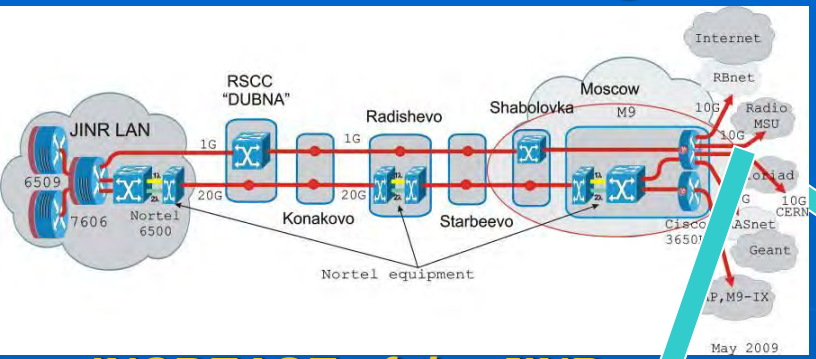


Russia Normalized CPU time per SITE LHC VO (November 2011 - May 2012)

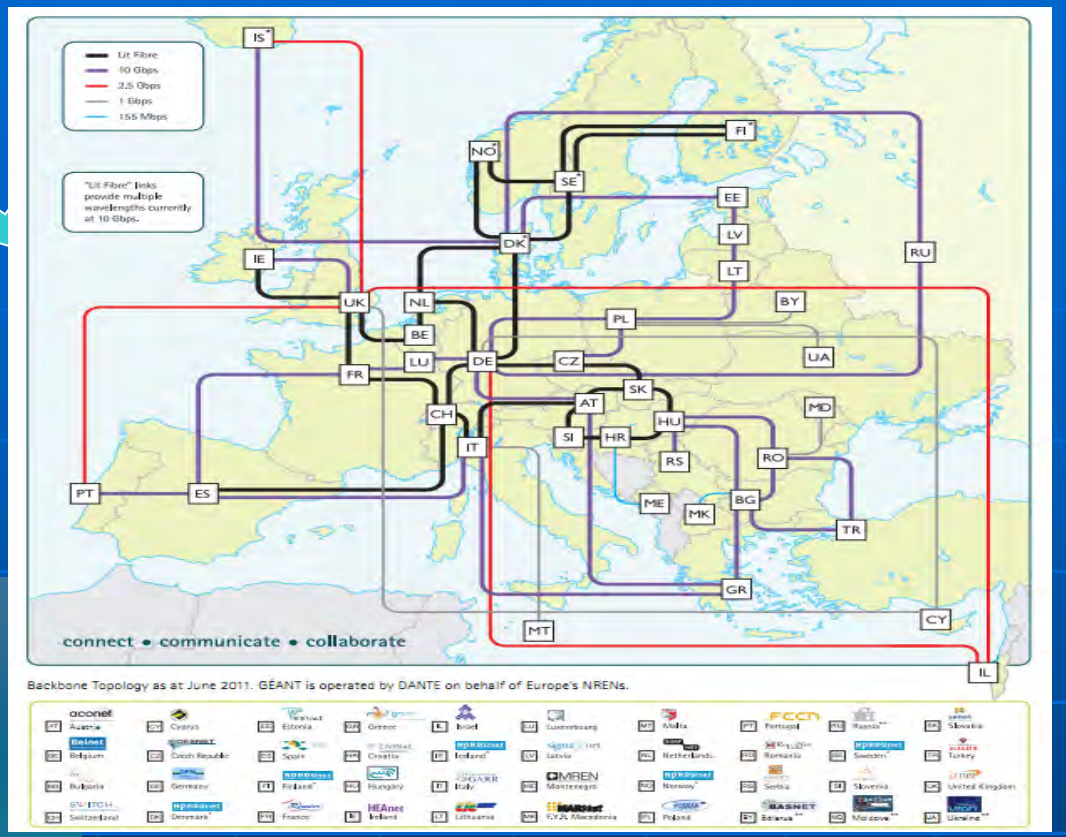




Connectivity of JINR Member States



INCREASE of the JINR - Moscow data link:
20 Gbps in 2009
800 Gbps in 2016



TEIN3: The Research and Education Network for Asia-Pacific

Vietnam

GÉANT3 Pan-European Backbone Consortium of 34 NRENs

Bulgaria, Czech, Poland, Romania, Russia, Slovakia

Ukraine, Belarus, Azerbaijan, Armenia, Georgia, Moldova,

Member States of JINR Normalized CPU time per countries (November 2011 - May 2012)

JINR member states	Normalised CPU time
Armenia	73,537
Belarus	61,595
Bulgaria	30,729
Czech Republic	11,329,407
Poland	24,970,575
Romania	15,857,005
Russia JINR	38,631,958 19,196,647
Slovakia	2,425,657
Ukraine	1,197,441

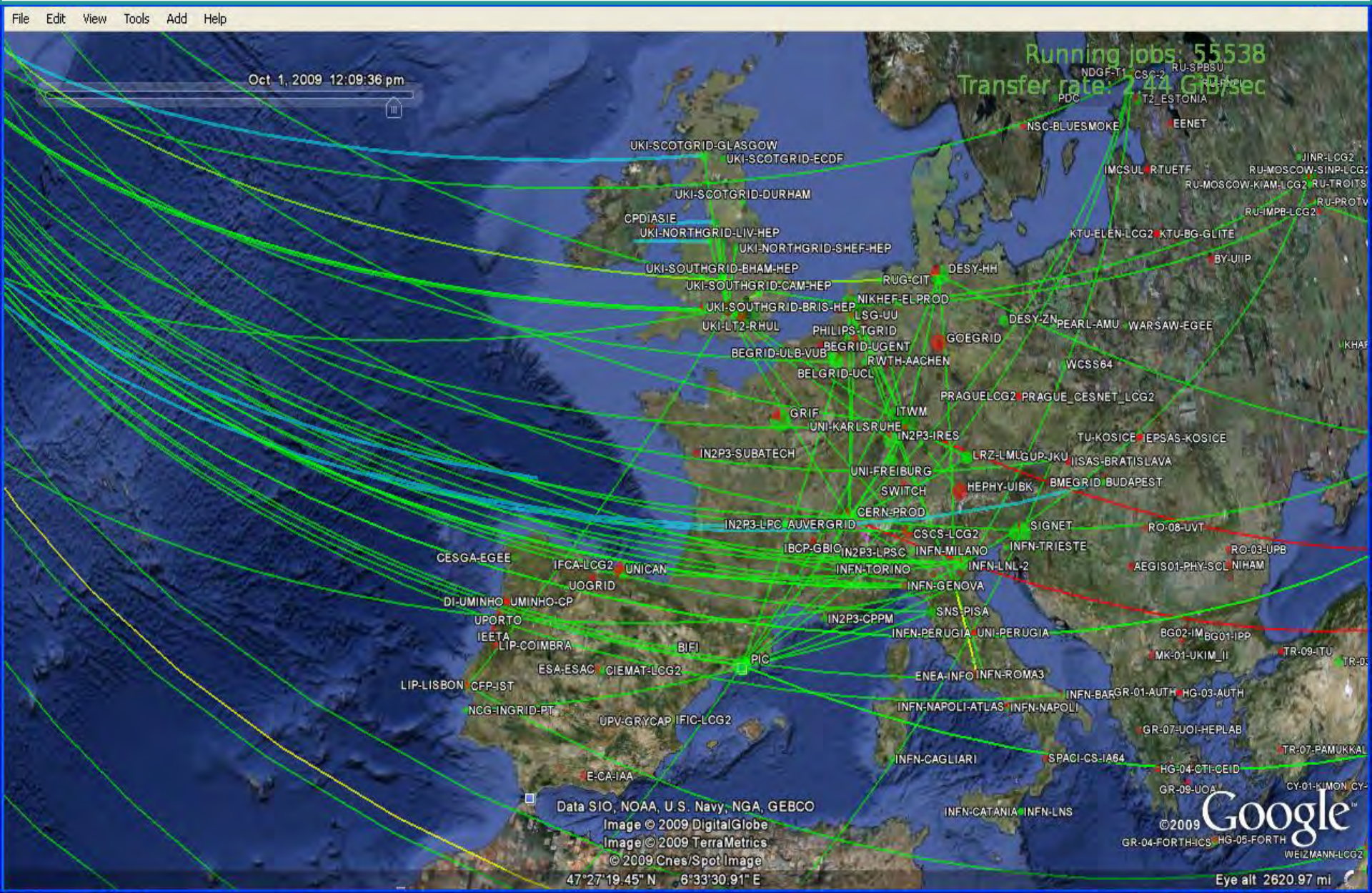
Worldwide LHC Computing Grid Project (WLCG)

The protocol between CERN, Russia and JINR on participation in LCG Project was approved in 2003.
MoU on Worldwide LHC Computing Grid (WLCG) signed by Russia and JINR in October, 2007

The tasks of the Russia & JINR in the WLCG (2011 years):

- Task 1. MW (gLite) testing (supervisor O. Keeble)
- Task 2. LCG vs Experiments (supervisor I. Bird)
- Task 3. LCG monitoring (supervisor J. Andreeva)
- Task 4. Tier3 monitoring (supervisor J. Andreeva, A.Klementov)
- Task 5/6. Genser/ MCDB (supervisor W. Pokorski)

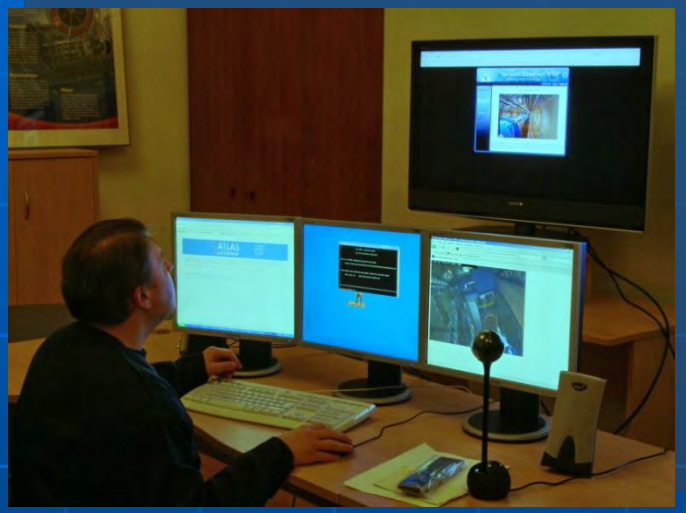
The Worldwide LHC Computing Grid (WLCG)



System of remote access in real time (SRART) for monitoring and quality assessment of data from the ATLAS at JINR

One of the most significant results of the team TDAQ ATLAS at LIT during the last few years was the participation in the development of the project TDAQ ATLAS at CERN. The system of remote access in real time (SRART) **for monitoring and quality assessment of data from the ATLAS at JINR was put in operation.**

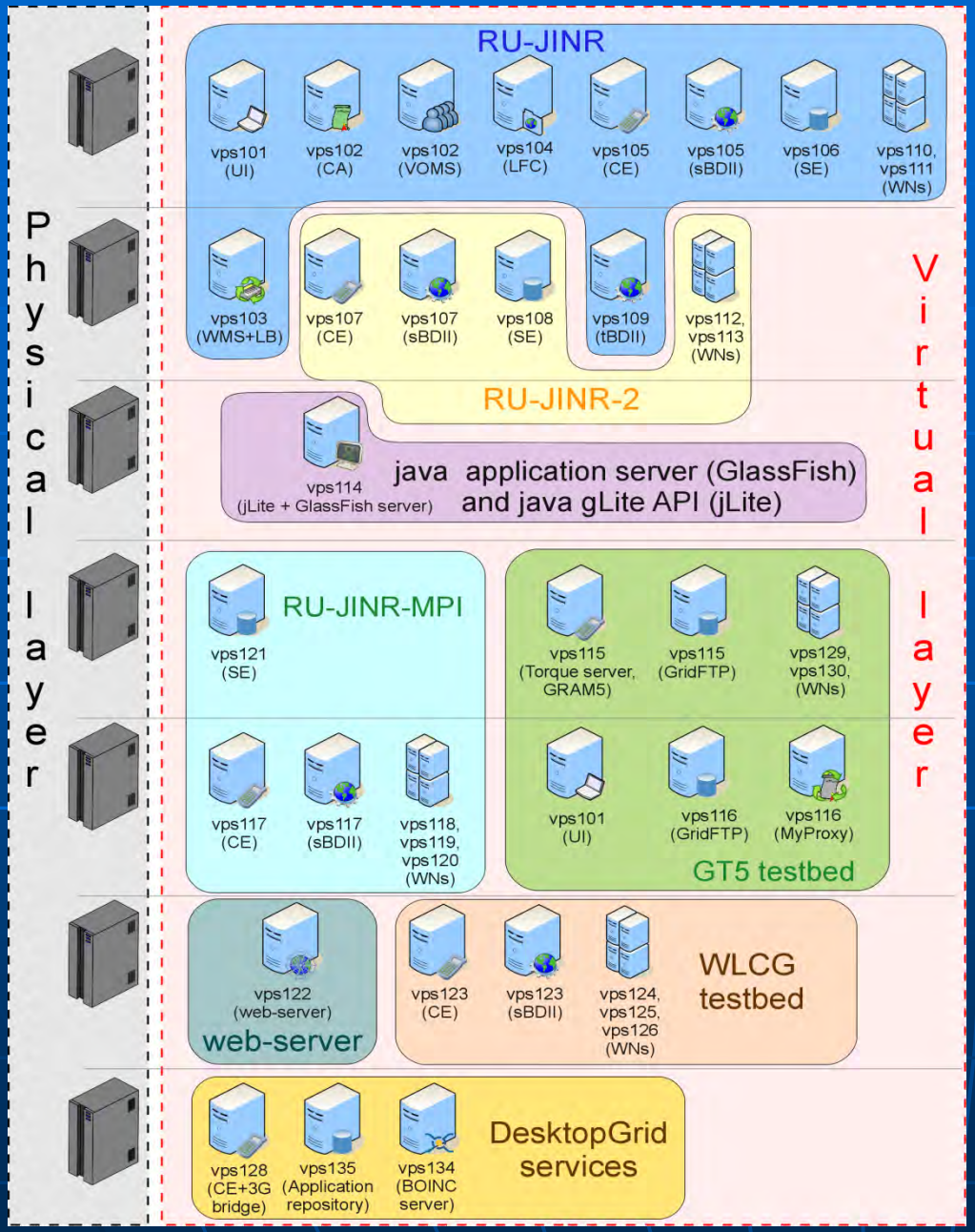
At present the system of remote access in real time is debugged on real data of the ATLAS experiment.



The work was supported by the Federal Agency on Science and Innovations of Russia, state contract No. 02.514.11.4083

JINR Monitoring and Analysis Remote Centre

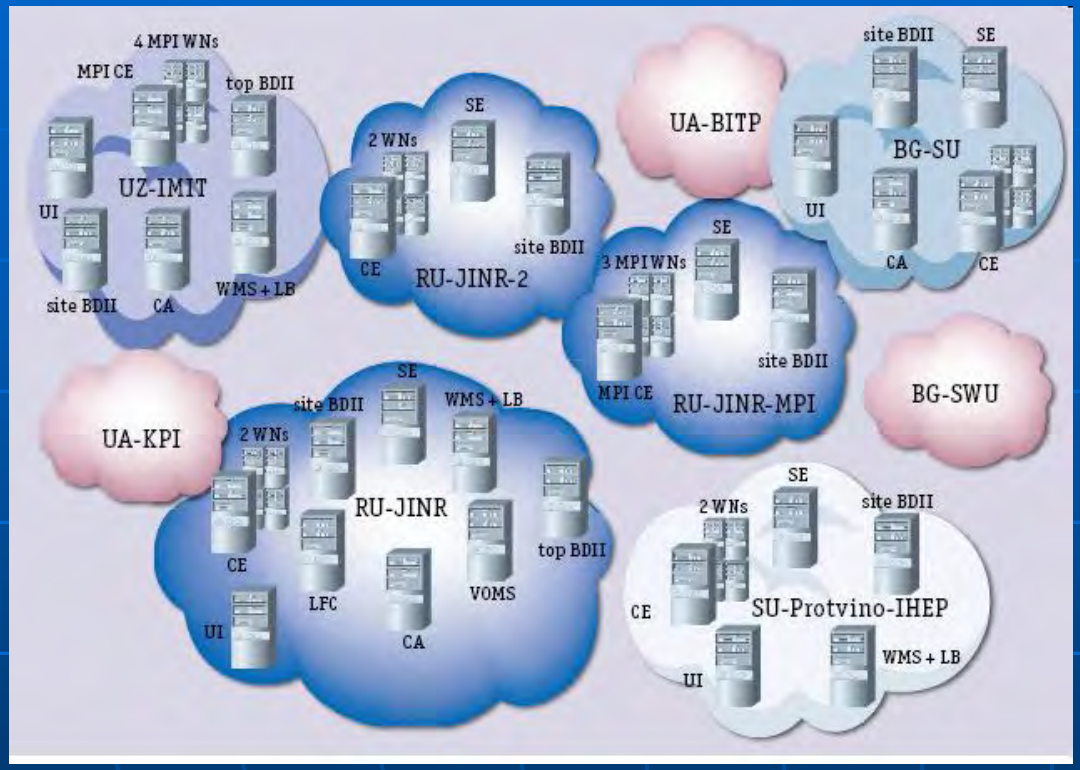
- Monitoring of detector systems
- Data Monitoring / Express Analysis
- Shift Operations (except for run control)
- Communications of JINR shifter with personal at CMS Control Room (SX5) and CMS Meyrin centre
- Communications between JINR experts and CMS shifters
- Coordination of data processing and data management
- Training and Information



T-infrastructure implementation

- All services are deployed on VMs (OpenVZ)
- Main parts:
  - three grid sites on gLite middleware,
  - GT5 testbed,
  - desktop grid testbed based on BOINC,
  - testbed for WLCG activities.
- Running since 2006

JINR Grid-infrastructure for training and education – first step towards construction of the JINR Member States grid-infrastructure



- Consists of three grid sites at JINR and one at each of the following sites:
  - Institute of High-Energy Physics - IHEP (Protvino),
  - Institute of Mathematics and Information Technologies AS of Republic of Uzbekistan - IMIT (Tashkhent, Uzbekistan),
  - Sofia University "St. Kliment Ohridski" - SU (Sofia, Bulgaria),
  - Bogolyubov Institute for Theoretical Physics - BITP (Kiev, Ukraine),
  - National Technical University of Ukraine "Kyiv Polytechnic Institute" - KPI (Kiev, Ukraine).
- Letters of Intent with Moldova "MD-GRID", Mongolia "Mongol-Grid", Kazakhstan
- Project with Cairo University

ГРИД ННС

Participation in GridNNN project

- Grid support for Russian national nanotechnology network
  - To provide for science and industry an effective access to the distributed computational, informational and networking facilities
  - Expecting breakthrough in nanotechnologies
  - Supported by the special federal program

- Main points
  - based on a network of supercomputers (about 15-30)
  - has two grid operations centers (main and backup)
  - is a set of grid services with unified interface
  - partially based on Globus Toolkit 4

the globus toolkit

ГРИД ННС

GridNNN infrastructure

10 resource centers at the moment in different regions of Russia

- RRC KI, «Chebyshev» (MSU), IPCP RAS, CC FEB RAS, ICMM RAS, JINR, SINP MSU, PNPI, KNC RAS, SPbSU

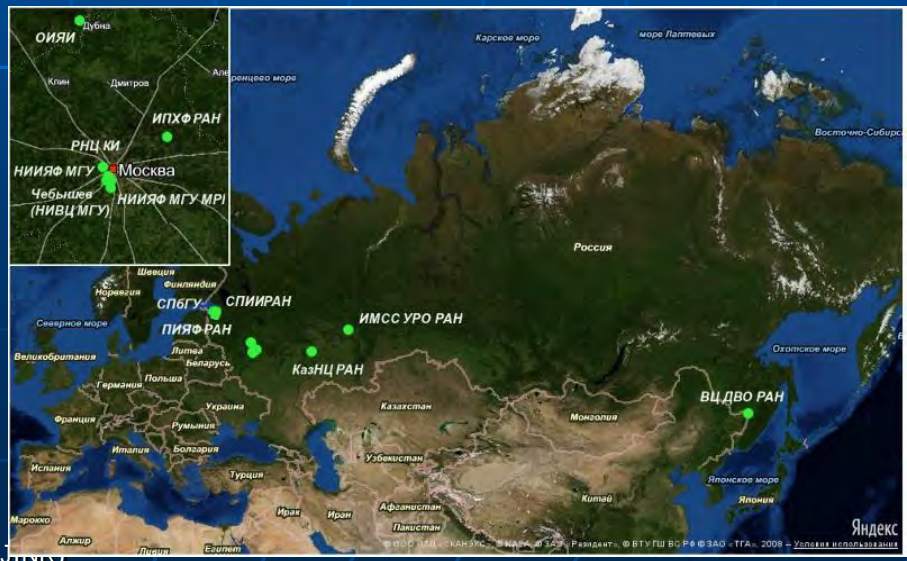
НИИЯФ МГУ

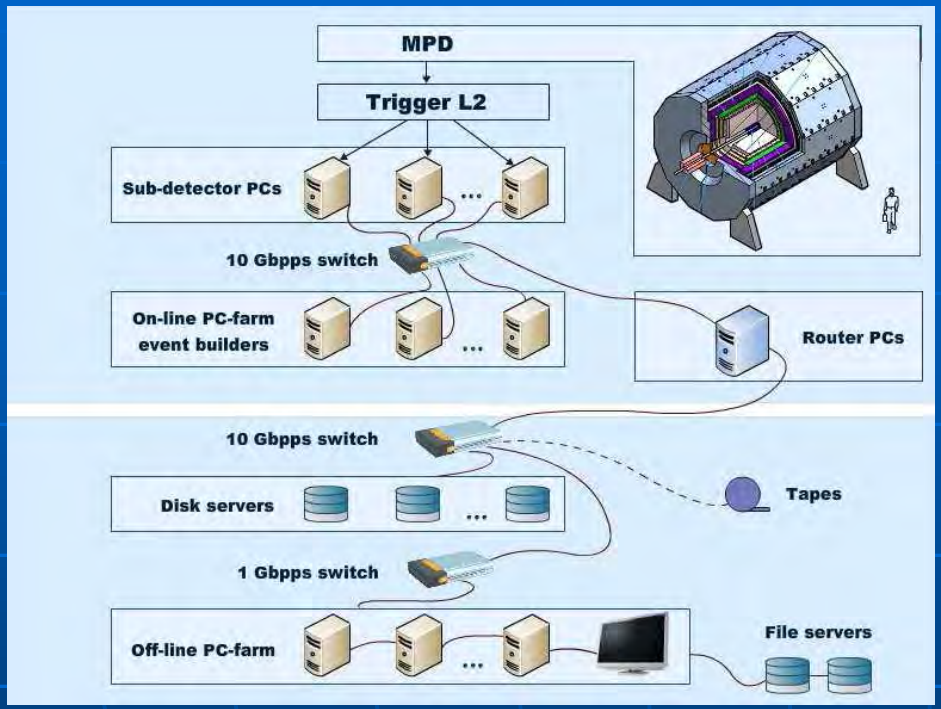
Saint-Petersburg State University

Russian Grid Network

- Goal — to make a computational base for hi-tech industry and science
- Using the network of supercomputers and original software created within recently finished GridNNN project
- Some statistics
  - 19 resource centers
  - 10 virtual organizations
  - 70 users
  - more than 500'000 tasks processed

ГРИД ННС





MPD data processing model

(from “The MultiPurpose Detector – **MPD Conceptual Design Report v. 1.4** ”)

Project: Model of a shared distributed system for acquisition, transfer and processing of very large-scale data volumes, based on Grid technologies, for the NICA accelerator complex

Terms: 2011-2012

Cost: federal budget - 10 million rubles, extrabudgetary sources - 25% of the total cost

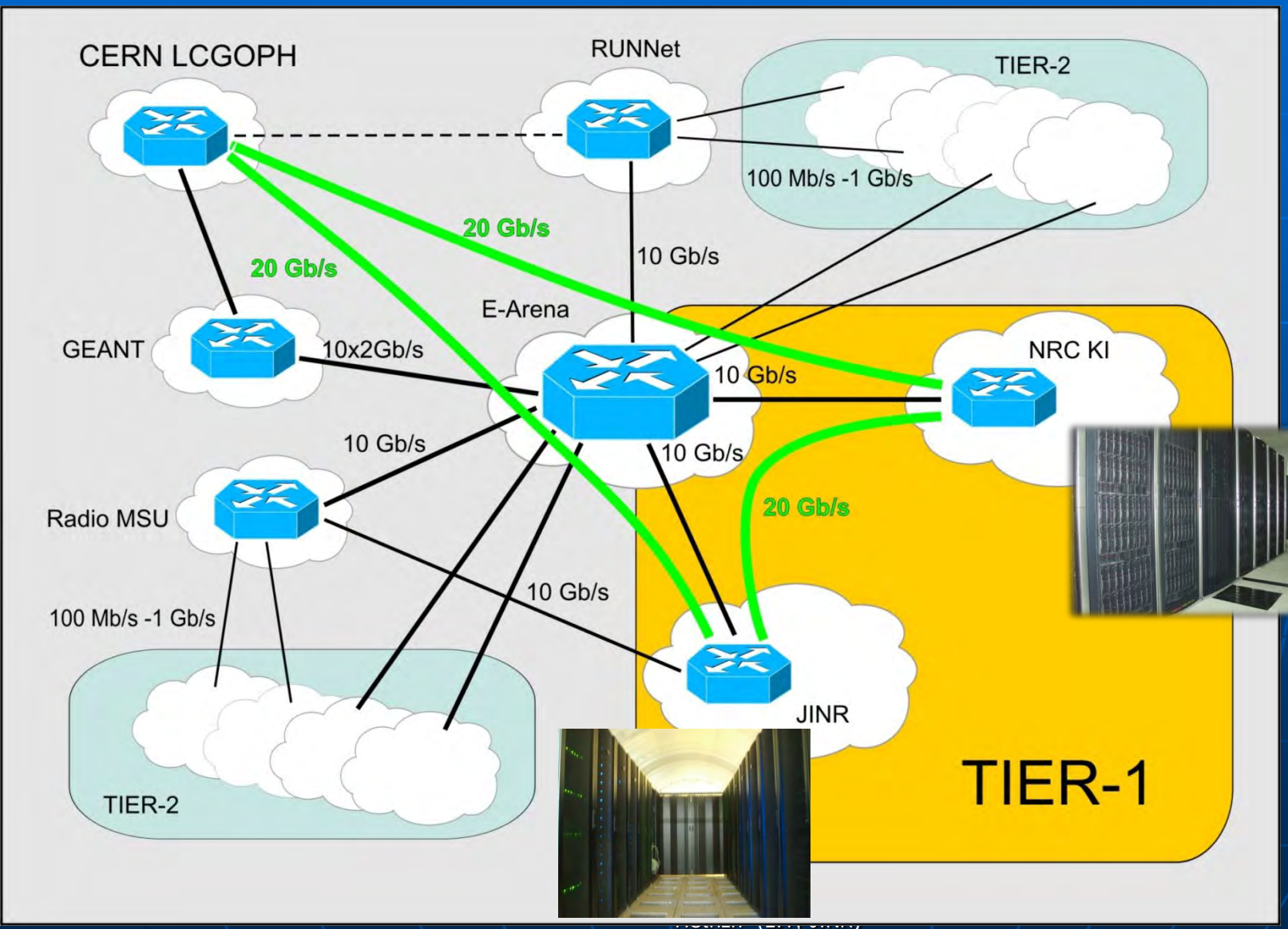
Leading executor: LIT JINR

Co-executor: VBLHEP JINR

WLCG Tier1 in Russia

- Proposal to create the LCG Tier-1 center in Russia: official letter by A. Fursenko, Minister of Science and Education of Russia, has been sent to CERN DG R. Heuer in March 2011
- The corresponding points were included to the agenda of Russia – CERN 5x5 meeting in 2011
  - serving all four experiments: ALICE, ATLAS, CMS and LHCb
  - ~10% of the total existing Tier1 resources (without CERN)
  - increase by 30% on each year
  - draft planning (proposal under discussion) to have prototype in the end of 2012 and full resources in 2014 to be ready for the start of the next LHC session

Joint NRC "Kurchatov Institute" – JINR Tier1 Computing Centre



JINR Resources

JINR-LCG2 Tier2	April 2012	Dec. 2012	Dec. 2013
CPU (HEP-SPEC06)	20 000	30 000	45 000
Disk(Tbytes) CMS ATLAS ALICE	995 360 360 275	1800 660 660 480	3000 1100 1100 800
Tape (Tbytes)	-	-	5000

JINR-CMS Tier1	Dec. 2012 Prototype	Sep. 2014 Start
CPU (HEP-SPEC06)	5 000	50 000
Disk(Tbytes) CMS	500	8 000
Tape (Tbytes)	500	15 000

Frames for Grid cooperation of JINR

- Worldwide LHC Computing Grid (WLCG);
- **EGI-InSPIRE**
- RDIG Development
- CERN-RFBR project "Global data transfer monitoring system for WLCG infrastructure"
- NASU-RFBR project "Development and support of LIT JINR and NSC KIPT grid-infrastructures for distributed CMS data processing of the LHC operation"
- BMBF grant "Development of the Grid-infrastructure and tools to provide joint investigations performed with participation of JINR and German research centers"
- "Development of Grid segment for the LHC experiments" was supported in frames of JINR-South Africa cooperation agreement;
- Development of Grid segment at Cairo University and its integration to the JINR GridEdu infrastructure
- JINR - FZU AS Czech Republic Project "The GRID for the physics experiments"
- JINR-Romania cooperation Hulubei-Meshcheryakov programme
- JINR-Moldova cooperation (MD-GRID, RENAM)
- JINR-Mongolia cooperation (Mongol-Grid)
- JINR-Slovakia cooperation
- JINR- Kazakhstan cooperation (ENU Gumelev)
- Project "Russian Grid Network"

The Fourth International Conference "Distributed Computing and Grid-technologies in Science and Education“ – GRID’2010

- 252 participants from 21 countries: Armenia, Belarus, Bulgaria, Hungary, Germany, Greece, Georgia, Iceland, Kazakhstan, Moldova, Myanmar, Poland, Russia, Romania, USA, Uzbekistan, Ukraine, France, Czechia, Switzerland, Sweden as well as from CERN and JINR.
- 56 universities and research centers of Russia.
- 8 sections: WLCG - worldwide Grid for processing data from LHC at CERN, Grid-applications, Grid in business, distributed computing and Grid-technologies in education, GridHHC – Grid of the national nanotechnology network, methods and algorithms for distributed computing, Grid-infrastructure and "cloud" computing.
- Round tables on using grid-technologies in business and on training in grid-technologies and their application in education.
- 36 plenary talks, 78 sectional talks.

http:// nec2011.jinr.ru

uclear Electronics & Computing - Mozilla Firefox

Справка

ru/topics.php

XXIII International Symposium on Nuclear Electronics & Computing

Bulgaria, Varna,
12-19 September, 2011.

NEC'2011

- First Announcement
- Organizing Committee
- Topics
- Registration Form
- Participants list
- Abstracts
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The main topics of the symposium are:

- Detector & Nuclear Electronics;
- Accelerator and Experiment Automation Control Systems. Triggering and Data Acquisition.
- Computer Applications for Measurement and Control in Scientific Research;
- Methods of Experimental Data Analysis;
- Data & Storage Management. Information & Data Base Systems;
- GRID & Cloud computing. Computer Networks for Scientific Research;
- LHC Computing;
- Innovative IT Education: Experience and Trends.

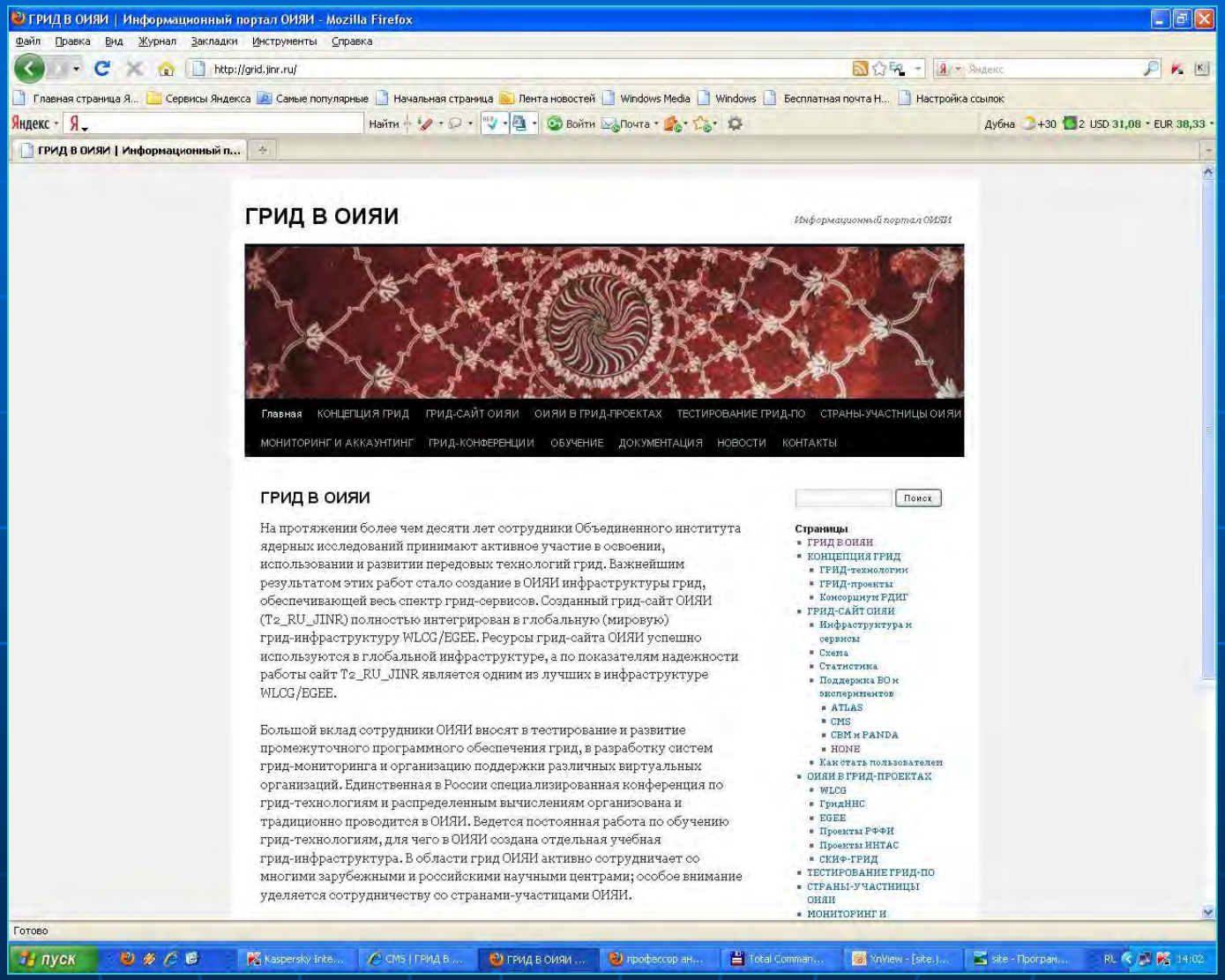
nec2011@cv.jinr.ru
JINR, Joliot-Curie 6, 141980 Dubna, Mos

WEB-PORTAL “GRID AT JINR” – “ГРИД В ОИЯИ”: http://grid.jinr.ru

A new informational resource has been created at JINR: web-portal “GRID AT JINR”.

The content includes the detailed information on the JINR grid-site and JINR’s participation in grid projects:

- КОНЦЕПЦИЯ ГРИД
  - ГРИД-технологии
  - ГРИД-проекты
  - Консорциум РДИГ
- ГРИД-САЙТ ОИЯИ
  - Инфраструктура и сервисы
  - Схема
  - Статистика
  - Поддержка ВО и экспериментов
    - ATLAS
    - CMS
    - CBM и PANDA
    - HONE
  - Как стать пользователем
- ОИЯИ В ГРИД-ПРОЕКТАХ
  - WLCG
  - ГридННС
  - EGEE
  - Проекты РФФИ
  - Проекты ИНТАС
  - СКИФ-ГРИД
- ТЕСТИРОВАНИЕ ГРИД-ПО
- СТРАНЫ-УЧАСТНИЦЫ ОИЯИ
- МОНИТОРИНГ И АККАУНТИНГ
  - RDIG-мониторинг
  - dCache-мониторинг
  - Dashboard
  - FTS-мониторинг
  - H1 MC-мониторинг
- ГРИД-КОНФЕРЕНЦИИ
  - GRID
  - NEC
- ОБУЧЕНИЕ
  - Учебная грид-инфраструктура
  - Курсы и лекции
  - Учебные материалы
- ДОКУМЕНТАЦИЯ
  - Статьи
  - Учебные материалы
- *НОВОСТИ*
- *КОНТАКТЫ*



Useful References:

- OPEN GRID FORUM: http://www.ogf.org

- GLOBUS: http://www.globus.org

- TERAGRID: http://www.teragrid.org

- Open Science Grid: http://opensciencegrid.org/

- LCG: http://lcg.web.cern.ch/LCG/

- EGEE: http://www.eu-egee.org

- EGEE-RDIG: http://www.egee-rdig.ru

- EGI: http://web.eu-egi.eu/
- Grid in JINR: http://grid.jinr.ru

- Grid in Russia: http://gridclub.ru
- International Science Grid this Week: http://www.isgtw.org/

The blind men and the elephant in the room