

# ***Grids in Brazil***

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UNESP*



# Outline



- **HEP Grid Initiatives**
  - Research Groups / Clusters
  - Cyberinfrastructure
  - SPRACE
    - DØ MC and Data Reprocessing
    - CMS Tier 2
  - HEPGrid-Brasil (UERJ)
- **New Initiative: GridUNESP**
- **EELA and OSG role in Latin America**

# HEP Grid Initiatives

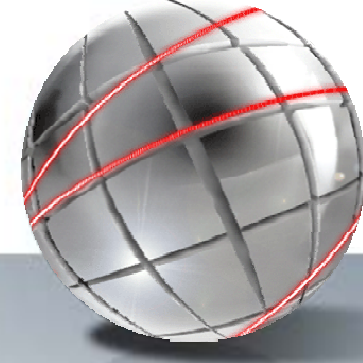


- **SPRACE**
  - São Paulo State University (UNESP)
  - DØ and CMS
  
- **HEPGrid**
  - Rio de Janeiro State University (UERJ)
  - DØ and CMS
  
- **Star–São Paulo**
  - University of São Paulo (USP)
  - Star and Alice
  
- **LAPE / CBPF**
  - Federal University of Rio de Janeiro (UFRJ)
  - Brazilian Center for Research in Physics (CBPF)
  - LHCb and Atlas



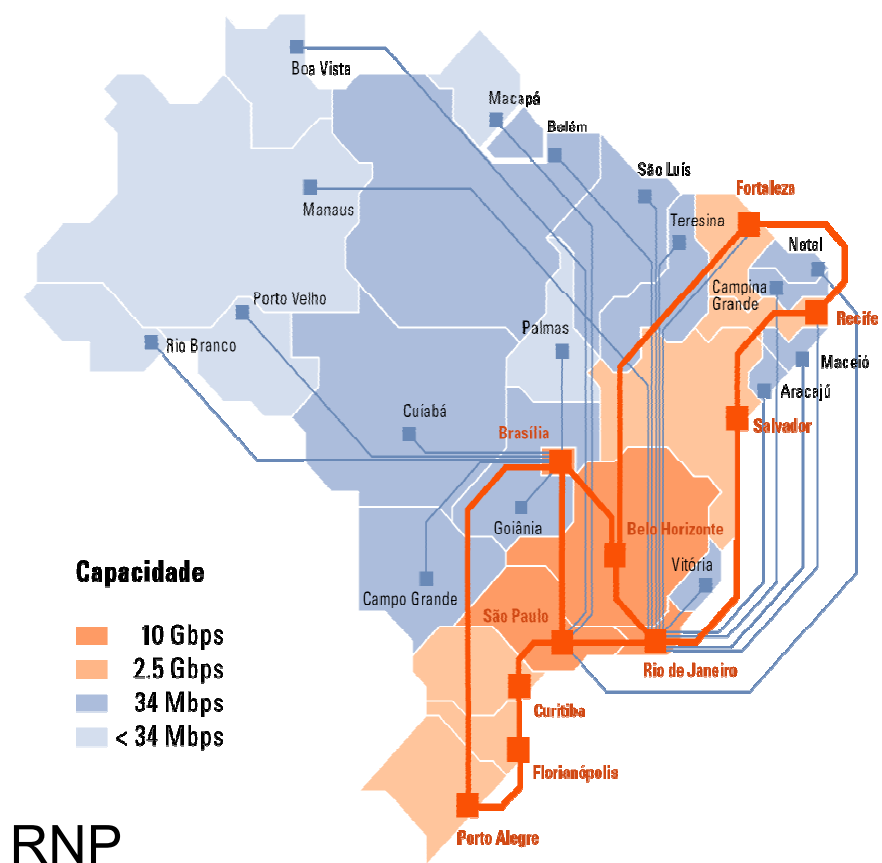
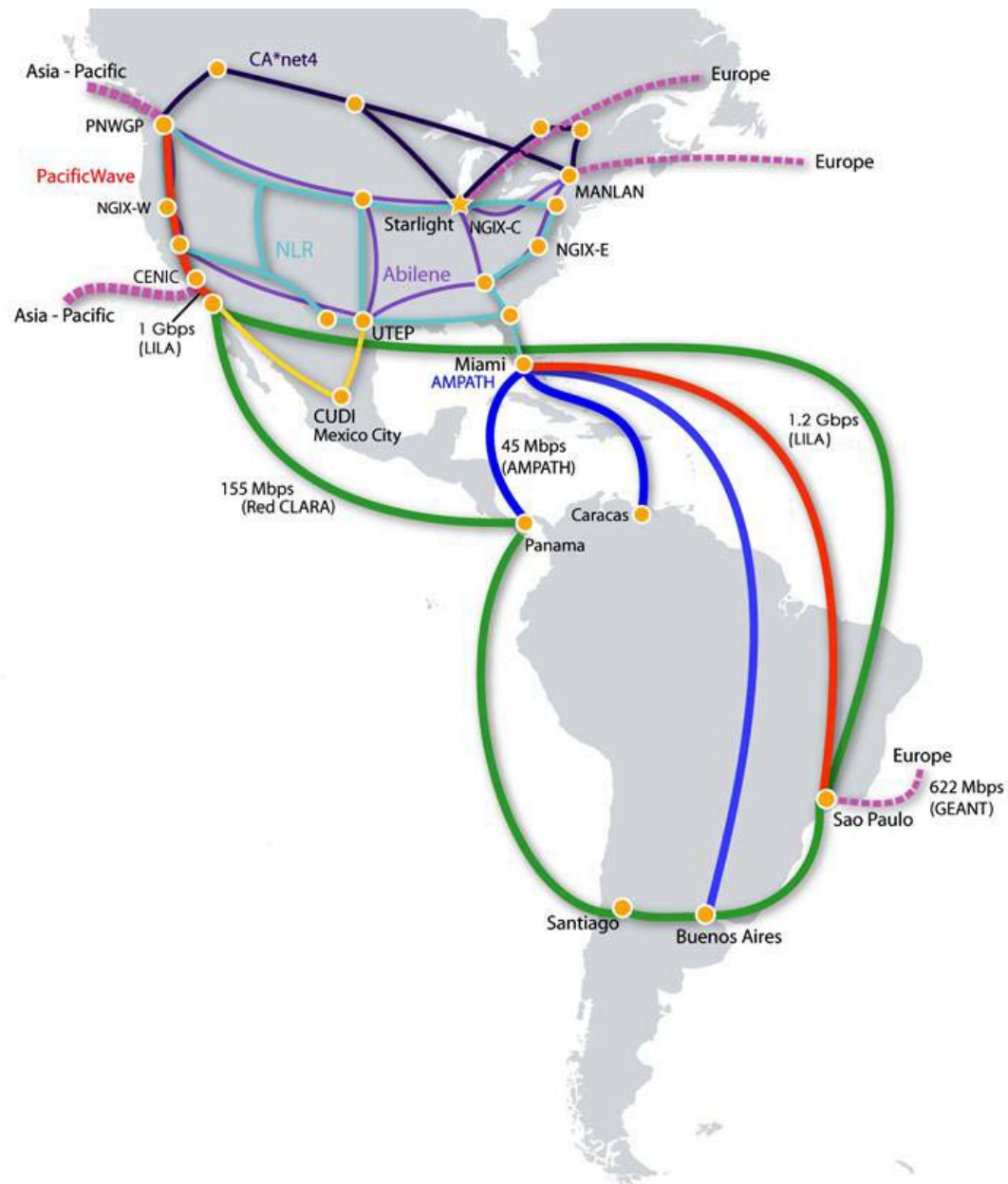
Status	Site Name	Grid Version	Jobs	Disks	Service	Loc	Facility
●	STAR-SAO_PAULO	osg 0.4.1	0/14	42/50	CS WS	BRAZIL	USP
●	SPRACE	osg 0.4.1	1/170	402/1747	CS WS	BRAZIL	UNESP
●	UERJ_HEPGRID	osg 0.4.1	0/0	4/221	CS WS	BRAZIL	UERJ

# Some General Remarks



- Brazil participates in the **four** LHC Experiments
- Financial Support is limited
  - Important to share computing resources
- Partnership: **CMS**–Fermilab Tier 1 & **Atlas**–BNL Tier 1
  - Strong connection to **OSG**
- **LHCb** and **Alice**: very small US participation
  - Focused on European Grid solutions: **EGEE**
- Interoperability is an essential issue for us
- Network connection is improving very fast due to:
  - ICFA Standing Committee on Interregional Connectivity (Harvey Newman, chair)
  - CHEPREO project and WHREN-LILA link supported by NSF-FAPESP

# Networking



- RNP  
200 Institutions @ 1 Gbps  
Dark fiber in 27 metropolitan areas
- ANSP (São Paulo)  
São Paulo Research Institutions  
GLBX, LANutilus
- WHREN/LILA (US)  
1.2 → 2.5 → 10 Gbps (2008?)
- RedCLARA (LA → GEANT, EU)  
155 → 622 Mbps

# São Paulo Regional Analysis Center



## – The Group

- Eduardo Gregores Professor
- Sérgio Lietti Postdoc
- Pedro Mercadante Postdoc
- Gustavo Pavani Postdoc
- Rogerio Iope System Manager
- Marco Dias System Manager
- Thiago Tomei Graduated Student
- Wescley Teixeira Undergraduate
- João Marques Outreach

## – DØ Experiment (since 1999)

- Monte Carlo production
- Data Reprocessing

## – CMS Experiment (since 2005)

- Participated in the CSA06

## – Cluster

- 90 Dual/Duo Xeon (240 processors)
- Computing Power: 300 kSi2k
- Storage Capacity : 20 TB

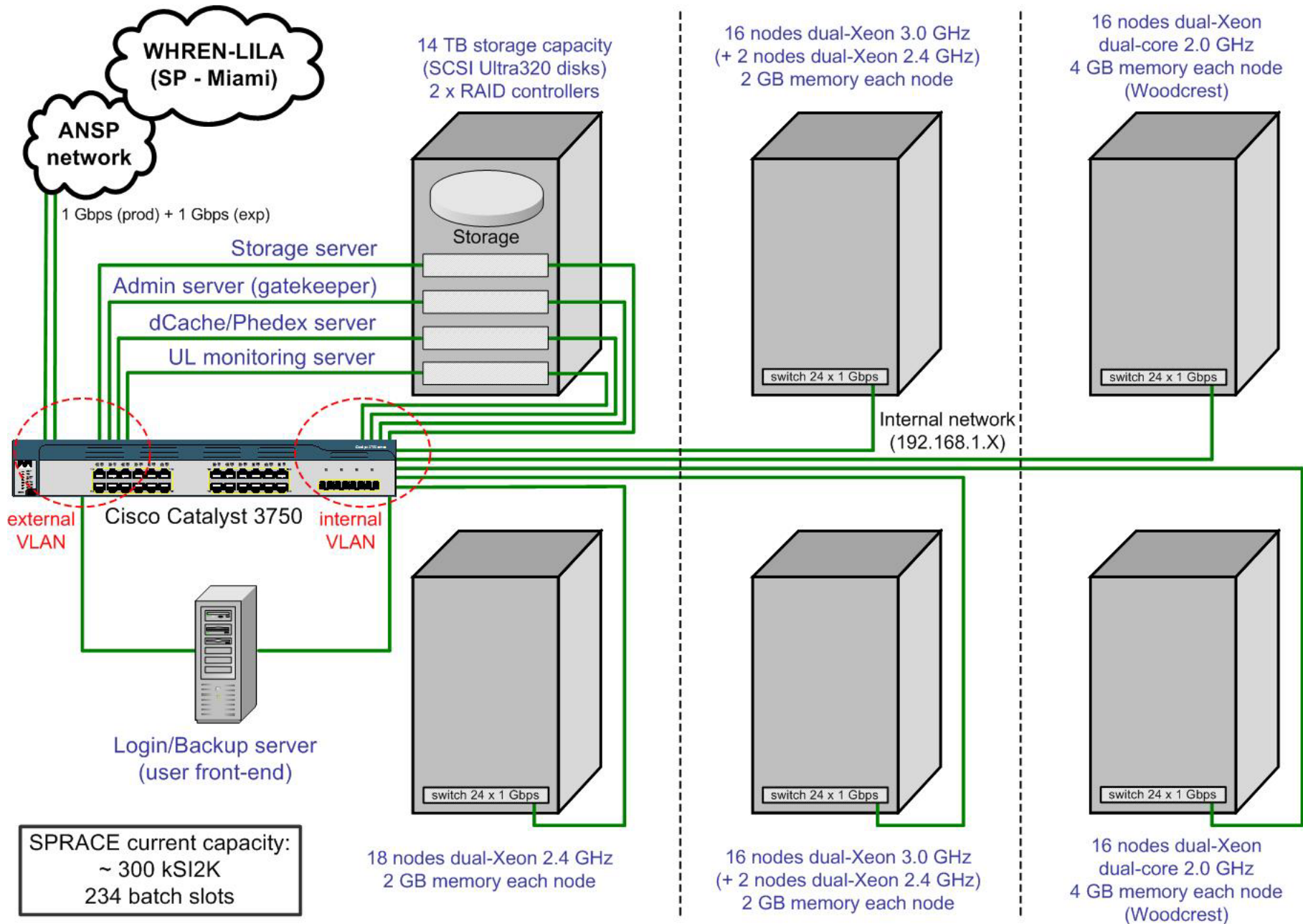
## – Network Connection

- Direct Gigabit connection with USA
- Direct Gigabit connection with Rio
- Optical connection for network test bed (UltraLight/Kyatera)

## – Grid Computing Initiatives

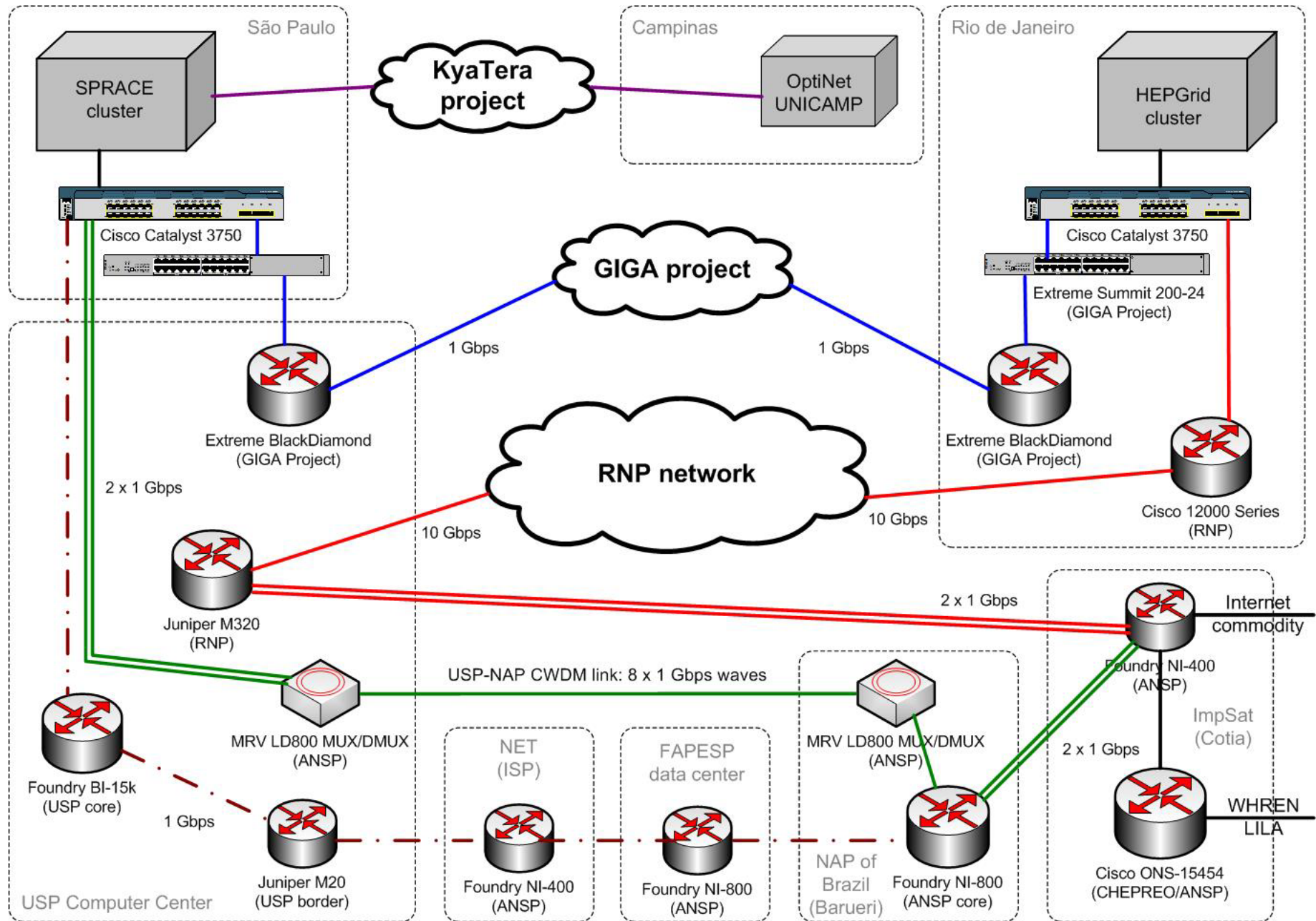
- Distributed Organization for Scientific Analysis and Research (DOSAR) site
- Operational SAMGrid site
- Open Science Grid member site
- Operating as a CMS Tier2

# SPRACE Cluster Infrastructure



SPRACE current capacity:  
 ~ 300 kSI2K  
 234 batch slots

# SPRACE Network





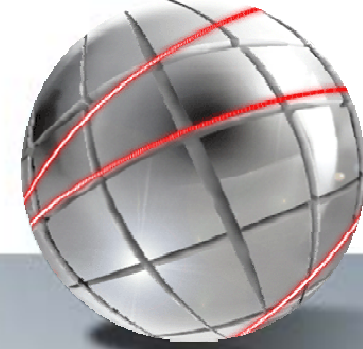
# DOSAR & SAMGrid



Participating Experiments:

- DO
- CDF

# DØ Data Reprocessing



DØ data is often reprocessed using the latest version of the Reconstruction Software:

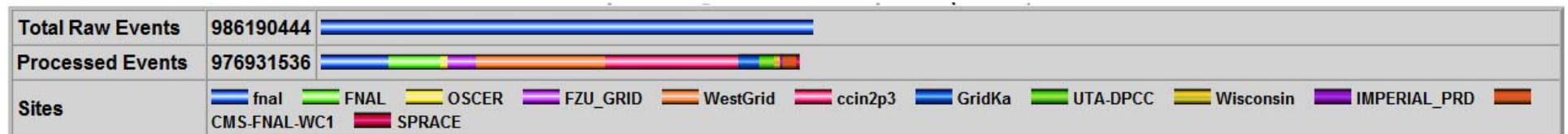
P14: November 2003-January 2004

P17: March-November 2005

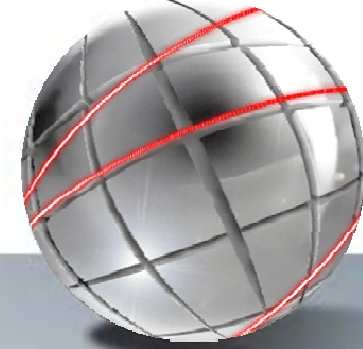
P20: February-April 2007

- **SPRACE**

- Participated in the P17 Reprocessing, together with seven other farms from US, Canada, and Europe.
- Started reprocessing in August 2005
- Reprocessed 10 Million events using SAMGrid infrastructure



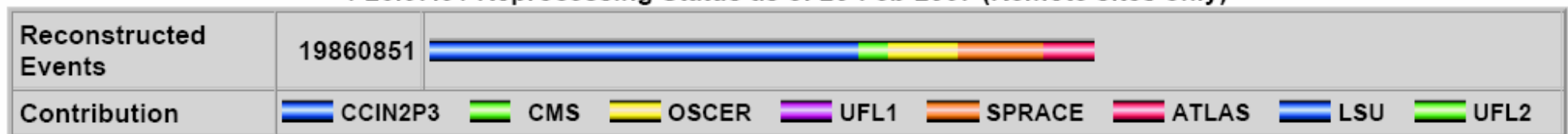
# P20 DØ Reprocessing



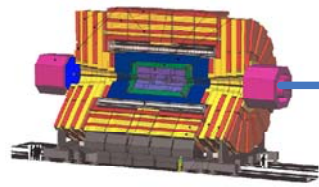
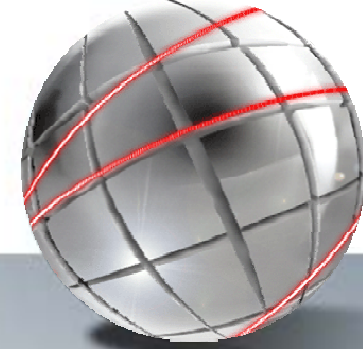
- 500 million events to be processed  
February to April 2007
- 2,300 CPU's will be required  
30 sec per event @ 1 GHz CPU
- SAMGrid–OSG interoperability  
Jobs executed in OSG clusters

OSG Clusters	CPU's (DØ)
Oklahoma University	200
Indiana University	250
NERSC – LBL	250
University of Nebraska	256
CMS FNAL	250
<b>SPRACE Brazil</b>	<b>230</b>
CC-IN2P3 Lyon	500
LOUISIANA LTU-CCT	250 (128)
UCSD	300 (70)
PURDUE-ITaP	600 (?)

P20.07.01 Reprocessing Status as of 20-Feb-2007 (Remote sites only)



# CMS Tier 2



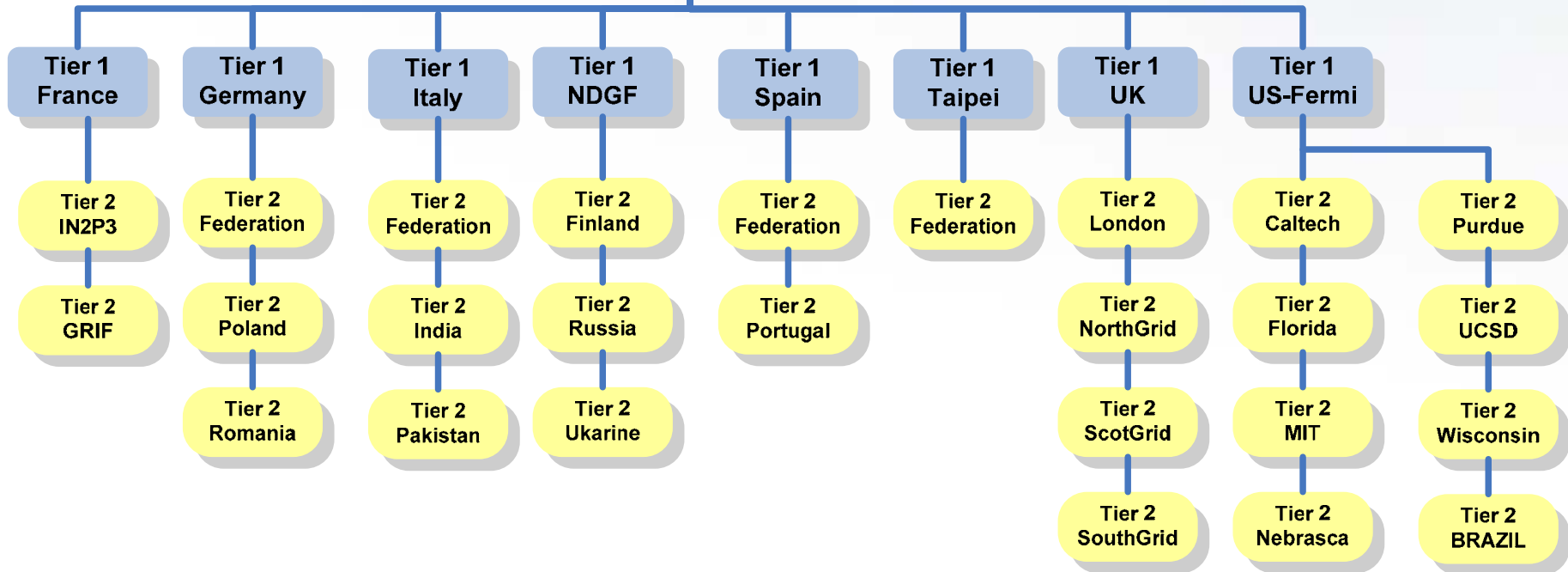
1 PByte/sec

Online System

100 MBytes/sec

Tier 0  
CERN

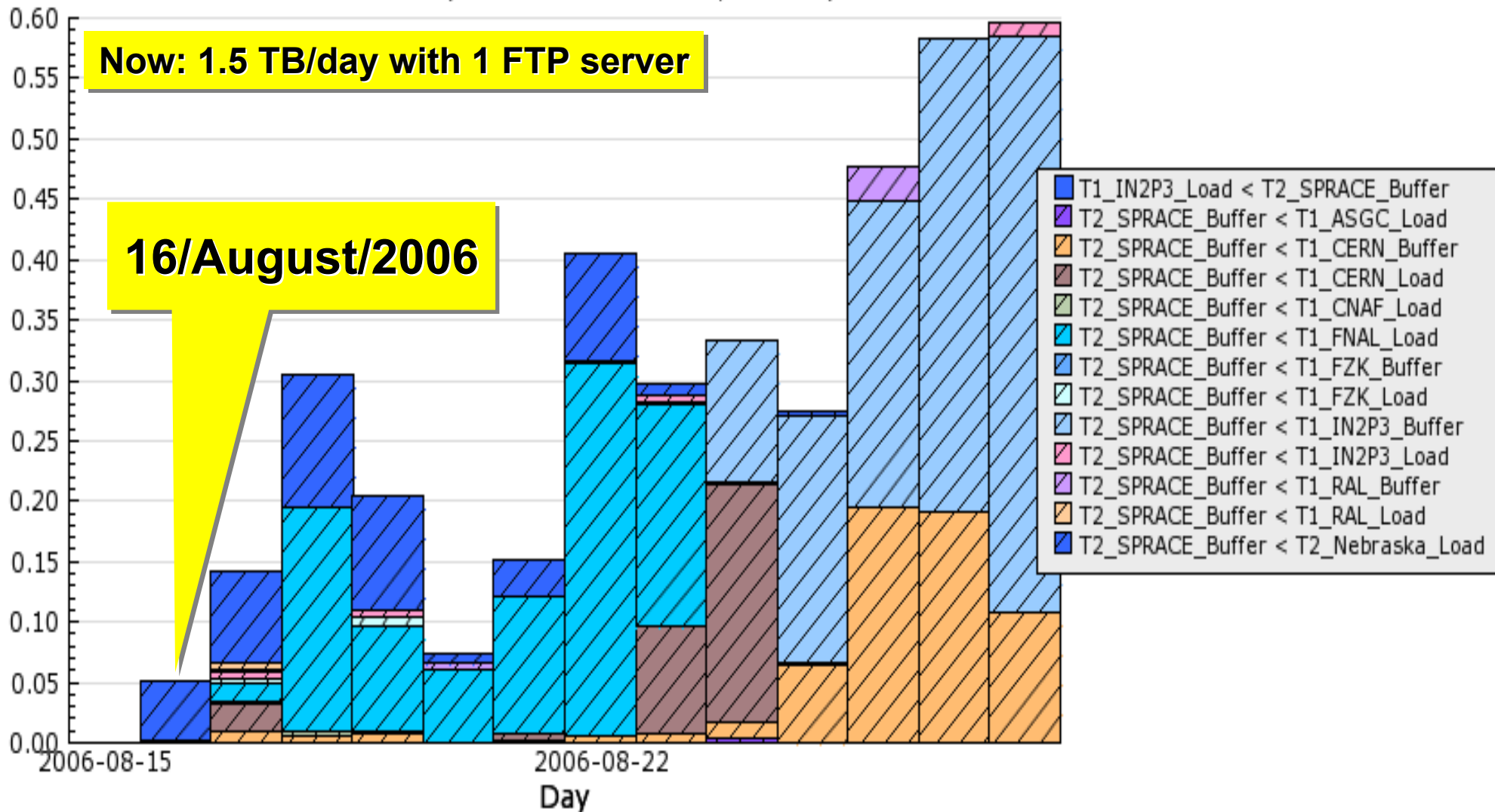
10 Gbps



# Data Transfers from OSG and LCG

## PhEDEx SC4 Data Transfers By Links matching 'SPRACE'

Last 14 Days at 2006-08-28 21:10, last entry 2006-08-28 GMT



# OSG/CMS Setup at SPRACE



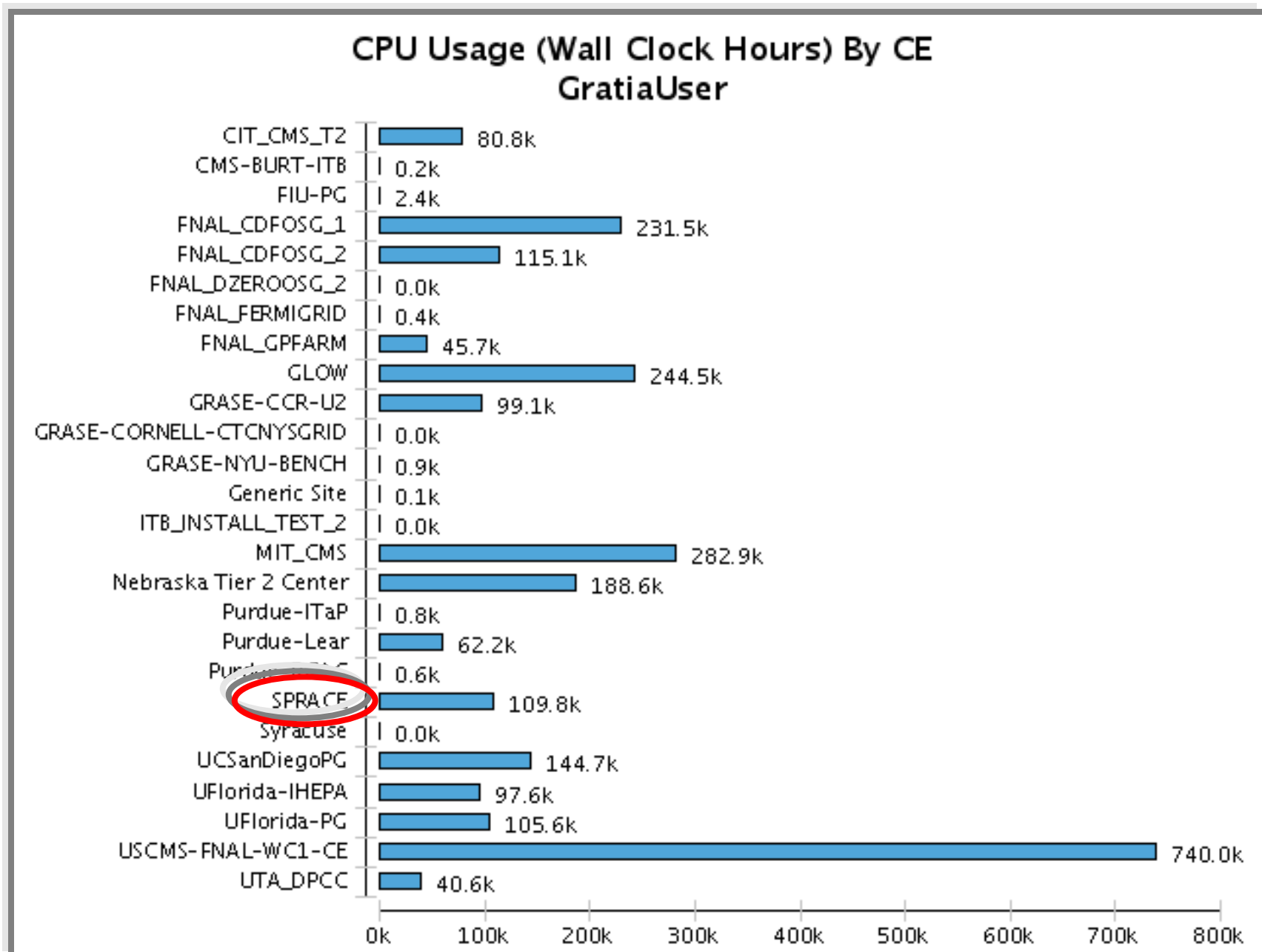
## Computing Element Configuration

- Site Name: SPRACE
- OSG 0.4.1 Suite
- Gums/Prima Authentication Scheme:
  - Role Based Supported VO's:  
cms, uscms, usatlas, osg, mis, fmri, grase, gridex, ligo, ivdgl, gadu, glow, cdf, nanohub, dzero, sdss, ops.
- Condor 6.7.18 Batch System with 234 Slots
- VO Software on \$OSG\_APP area:
  - DZero: None  
Software pulled by all jobs  
Jobs forwarded from SAMGrid to OSG
  - CMS: CMSSW  
0\_9, 1\_0, 1\_1 and 1\_2 families  
Centrally managed by CMS VO

## Storage Element Configuration

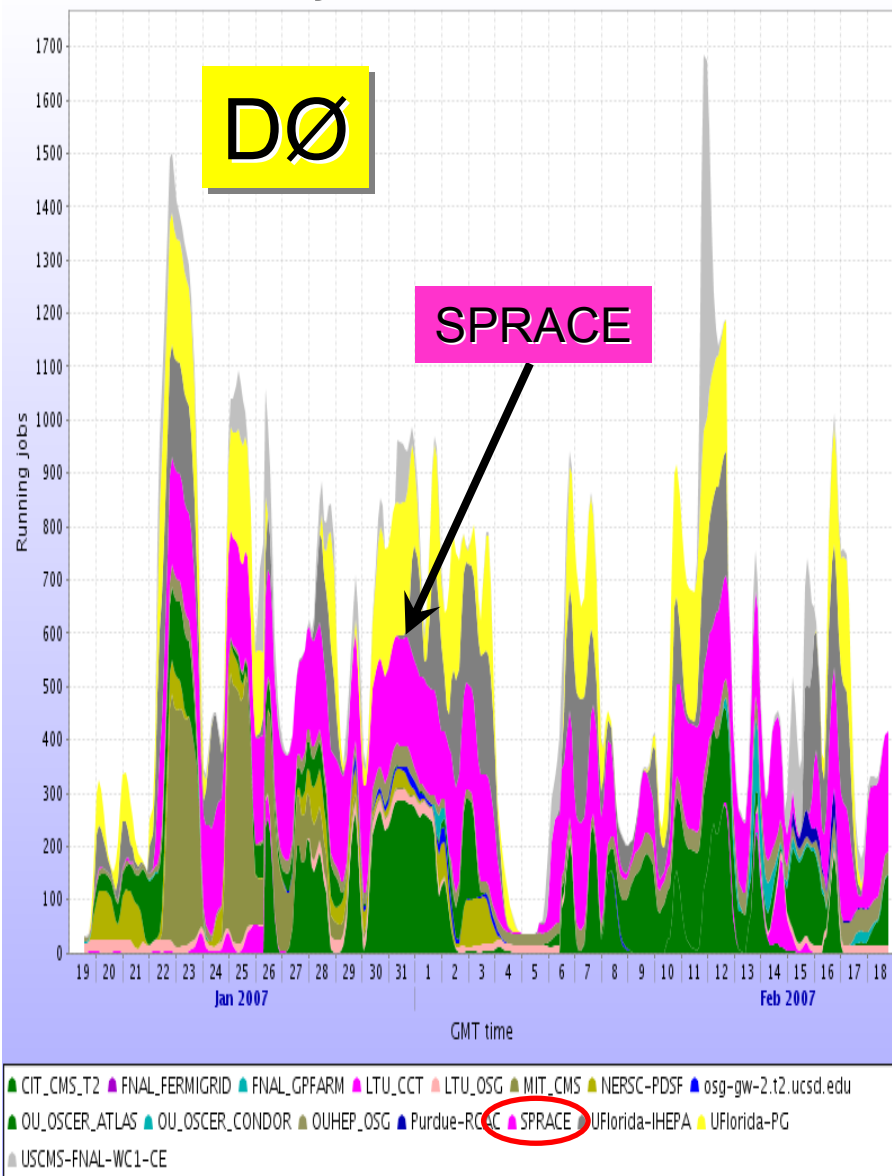
- Site Name: SPRACE:srm\_v1
- CMS PhEDEx 2.5.0.1 data catalogue
  - Node Name: T2\_SPRACE\_Buffer
- SRM and FTS data handling
- dCache / pNFS storage system:
  - 4 dCache Pools of 1.5 TB each on the disk server RAID-5 partitions.
  - dCache Pools on a single public IP
  - Plan: one pool on each worker node
- Only two servers:
  - PhEDEx, SRM, dCache and pNFS
  - FTP doors (6 RAID-5 partitions)

# Gratia Usage (last month)

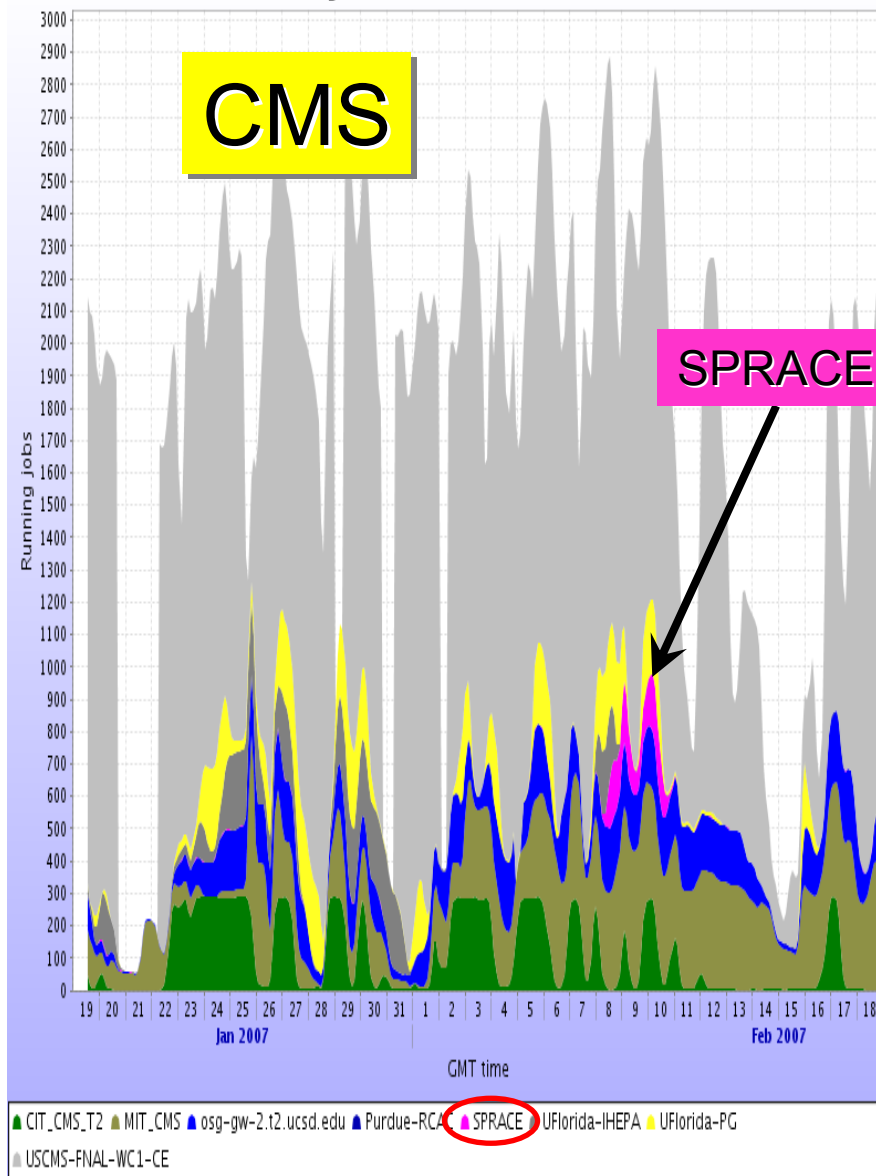


# MonALISA (last month)

Jobs status for DZERO VO

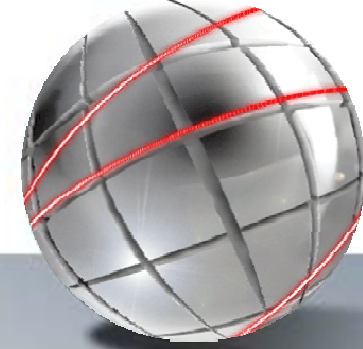


Jobs status for CMS VO





# Outreach: A Chart in Every School



## Standard Model of FUNDAMENTAL PARTICLES AND INTERACTIONS

The Standard Model is a quantum theory that summarizes our current knowledge of the physics of fundamental particles and fundamental interactions. Interactions are mediated by forces and by decay. (see: [list of particles](#))

**FERMIONS** matter constituents spin = 1/2, 3/2, 5/2, ...

Leptons spin = 1/2				Quarks spin = 1/2			
Flavor	Mass GeV/c <sup>2</sup>	Electric charge	Approx. Mass GeV/c <sup>2</sup>	Flavor	Approx. Mass GeV/c <sup>2</sup>	Electric charge	Approx. Mass GeV/c <sup>2</sup>
$\nu_e$ electron neutrino	$(0 - 0.13) \times 10^{-6}$	0		u	0.002	2/3	
$\nu_\mu$ muon neutrino	$(0.009 - 0.13) \times 10^{-6}$	0		d	0.005	-1/3	
$\nu_\tau$ tau neutrino	$(0.009 - 0.13) \times 10^{-6}$	0		s	0.005	-1/3	
e	0.000511	-1		c	1.3	2/3	
$\mu$ muon	0.106	-1		b	4.2	-1/3	
$\tau$ tau	$(0.04 - 0.14) \times 10^{-3}$	-1		t	173	2/3	
	1.777	-1		b	4.2	-1/3	

**BOSONS** force carriers spin = 0, 1, 2, ...

Unified Electroweak spin = 1			Strong (color) spin = 1	
Name	Mass GeV/c <sup>2</sup>	Electric charge	Name	Mass GeV/c <sup>2</sup>
$\gamma$ photon	0	0	g	0
$W^\pm$	80.39	-1		
$Z^0$	91.188	0		

**Structure within the Atom**

Quark Size =  $10^{-16}$  m  
Nucleon Size =  $10^{-15}$  m  
Atom Size =  $10^{-10}$  m

If the proton and neutron in this picture were 10 centimeters, then the quarks and electrons would be less than 0.1 mm in size and the entire atom would be about 10 cm across.

**Properties of the Interactions**

Property	Gravitational Interaction	Weak Interaction (Electroweak)	Electromagnetic Interaction
Acts on	Mass + Energy	Quarks, Leptons	Electrically Charged
Participating particles	All	Quarks, Leptons	Electrically Charged
Participating particles	Graviton (not yet observed)	$W^\pm, Z^0$	Photon, $\gamma$
Strength at $r = 10^{-16}$ m	$10^{-41}$	$10^{-4}$	1
Strength at $r = 10^{-10}$ m	$10^{-41}$	$10^{-4}$	1

**Particle Processes**

These diagrams are an artist's conception. The great colored lines represent the trail of quarks.

**Particle Antimatter**

For every particle there is a corresponding antiparticle, denoted by a bar over the particle symbol. Antiparticles are created in pairs and annihilate to produce energy. Some elementary particles (e.g.  $Z^0$  and  $\gamma$ ) are their own antiparticles.

**Universe Accelerating?**

The expansion of the universe appears to be accelerating. Is this due to Einstein's Cosmological Constant? Or, did observations reveal a new force of nature or even exotic matter (energy of space)?

**Why No Antimatter?**

Matter and antimatter were created in equal amounts in the Big Bang. Why do we see only matter in the universe and observe in cosmic rays?

## Composants élémentaires de la matière

## Les interactions fondamentales

Il existe des PARTICULES ASSOCIEES aux interactions fondamentales

10<sup>16</sup> m TERRE

1 m OBJET

10<sup>-10</sup> m CRISTAL

10<sup>-10</sup> m ATOME

10<sup>-14</sup> m NOYAU ATOMIQUE

10<sup>-16</sup> m PROTON

10<sup>-16</sup> m NEUTRON

10<sup>-16</sup> m ANTIPARTICULE

LEPTONS

QUARKS

GLUONS

BOSONS

PHOTONS

## Partículas Elementares

**DRAFT**

**Leptons**

Partículas com momento angular intrínseco (spin) 1/2 que não interagem através da força forte. Há 3 famílias de leptons compostas por um lepton carregado e um neutrino.

Os elétrons (e) compõe a eletrosfera que circunda o núcleo dos átomos e são responsáveis pelas ligações químicas entre os elementos. Em movimento produzem a corrente elétrica e geram campos magnéticos.

Os leptons muon ( $\mu$ ) e tau ( $\tau$ ), possuem características similares ao elétron, mas são muito mais pesados.

Os neutrinos ( $\nu$ ) são extremamente leves, não possuem carga elétrica e interagem muito fracamente com as outras partículas. São produzidos em decaimentos nucleares e na fusão nuclear que ocorre no Sol.

**Quarks**

Quarks são partículas que também interagem através da força forte e possuem carga fracionária (+2/3 e -1/3) e spin 1/2. Eles formam os hádrons (3 quarks, ou 1 quark + 1 antiquark) e não são observados livres.

Os quarks da primeira família, up (u) e down (d) formam os prótons (p) e nêutrons (n) e diversos mésons como os pions ( $\pi$ ) (u down) e  $\eta$  (ubar d).

As outras duas famílias de quarks, composta pelo strange (s) e charm (c), e pelo bottom (b) e top (t), não compõe a matéria usual sendo apenas produzidos em colisões de outras partículas.

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**Neutrón**

**Quarks**

**Glúon**

**Prótons**

**Núcleo**

**Leptons**

**Fótons ( $\gamma$ )**

**Glúons (g)**

**Bósons Vetoriais Massivos ( $W^\pm$  e  $Z^0$ )**

**Gravitacional:**

O fóton é o quantum do campo eletromagnético. Toda radiação eletromagnética, desde as ondas de rádio e televisão passando pela luz visível até os raios ultravioletas e gama, é formada por fótons. Partículas-ondas sem massa ou carga, os fótons são responsáveis pela transmissão da interação entre as partículas eletricamente carregadas.

O glúon desempenha para a interação forte um papel semelhante aos fótons para interação eletromagnética. Eles são trocados entre partículas que possuem "carga de cor" como os quarks. As três "cores" são as "cargas fortes" equivalentes às cargas elétricas positiva e negativa. A interação forte é 100 vezes mais intensa que a interação eletromagnética e seu alcance não vai além do núcleo atômico. Ela é responsável por manter os quarks ligados, formando prótons e nêutrons, e seu efeito residual (troca de mésons) mantém prótons e nêutrons unidos formando o núcleo atômico.

A interação fraca é intermediada pelos bósons carregados  $W^\pm$  e  $Z^0$  e pelo bóson neutro  $Z^0$ . A interação fraca é de curtíssimo alcance agindo em distâncias 1.000 vezes menores que o núcleo atômico e é 10.000 mais fraca que a interação eletromagnética. A interação fraca afeta tanto leptons quanto quarks e é responsável pelo decaimento beta, onde um nêutron do núcleo atômico se transforma em um próton emitindo um elétron e seu anti-nêutron (vide diagrama). Ela também desempenha importante papel na geração de energia das estrelas como o Sol.

A força gravitacional é uma centena de milhão de milhão de milhão de milhão de milhão de milhão de vezes mais fraca que todas as outras interações e portanto não tem nenhuma importância no mundo sub-atômico.

25,000 High Schools Discussion Forum

# T2-HepGrid Brasil (UERJ)



- **Timeline**

- **2000**: First project (T1 + several T2) submitted S&T Ministry
- **2001**: New Project submitted to FINEP by UERJ
- **2002**: FINEP – first part of the financial support.
- **2003**: Started the hardware acquisition
- **2004**: HEP Grid and Digital Divide Workshop @ UERJ

- **Hardware**

- 230 processing cores
- 2 RAIDs: (2 + 1) TB
- 40 TB of HD storage (dCache)

- **Connection (Fermilab Tier1)**

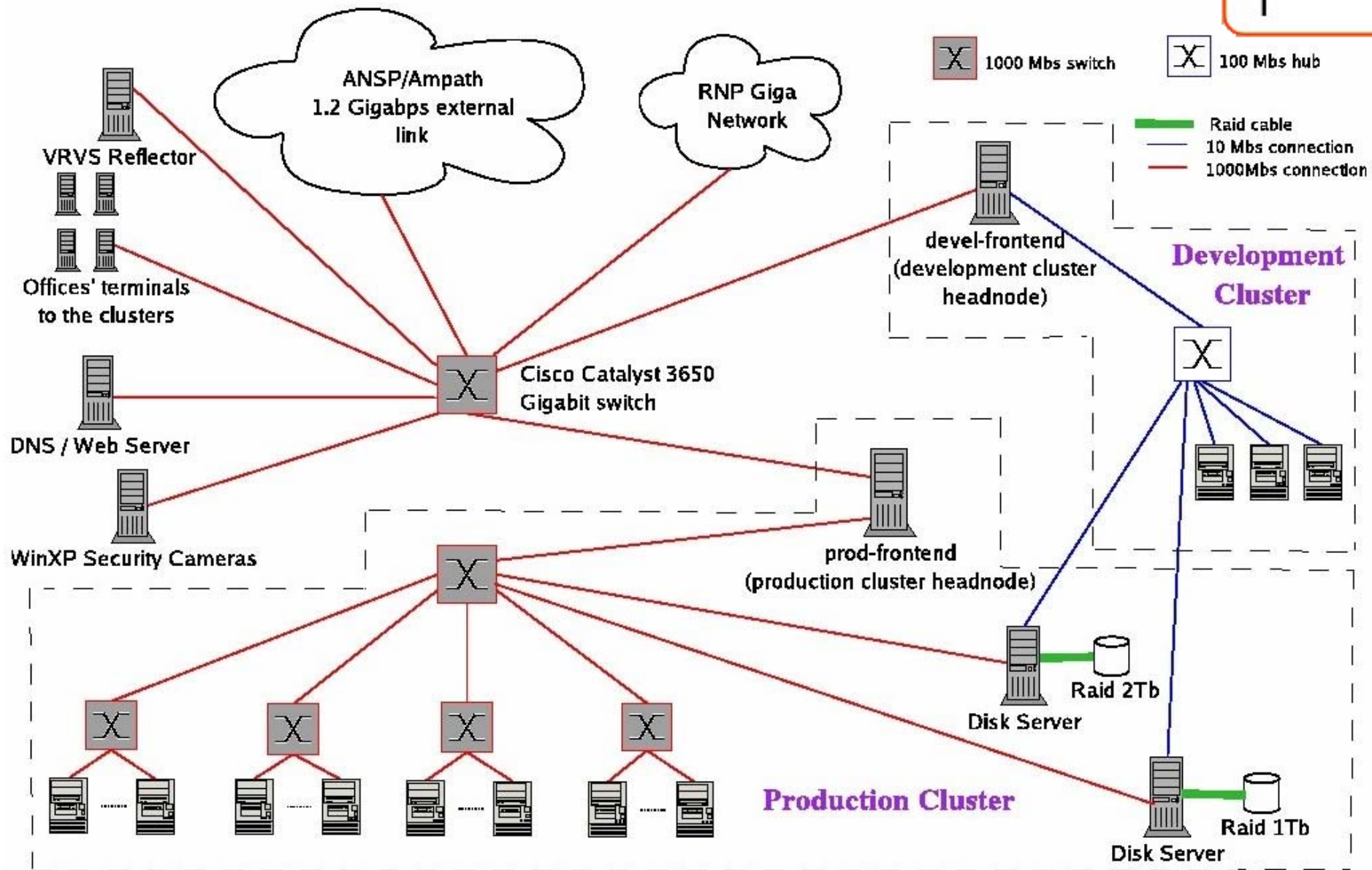
- 4 switches Gbit Ethernet
- 1 central switch Gbit Ethernet
- 1 switch 100Mbit + Gigabit port

- **Software**

- All Software from Grid Middleware, Condor, Globus,....
- OSG (Open Science Grid)
- Ultralight
- CMS/LHC/CERN – CMSSW
- DØ/Fermilab.











# UERJ Cluster Topology



# Site Overview and Installed Software



 Rocks headnode prod-frontend	Rocks 4.2.1 Condor 6.8.4	 srm Server	srm CentOS 4.4
 Phedex headnode	Phedex 2.6 Squid CentOS 4.4	 osgce Server	OSG 0.4.1 CentOS 4.4
 dCache admin headnode	dCache 1.7 CentOS 4.4	 gridftp1 Server	dCache 1.7 CentOS 4.4
 replica Server	Replica Manager CentOS 4.4	 devel headnode devel-frontend	Tests RHEL 3



# Students and Physics Topics

- DØ

- Ana Carolina (PhD): J/Psi Diffractive Production
- Helena Malbouisson (PhD): Diffractive Structure Function
- Renata Rodrigues (PhD): Diffractive Jets

- CMS

- Dilson Damião (MS, PhD): J/Psi Diffractive Production
- Antonio V. Pereira (MS, PhD):  $t\bar{t}$  Diffractive Production
- Marco Pacheco (MS, PhD): WW Diffractive Production
- Sheila Mara (MS): Double Diffraction
- Diogo Franczosi: Vector Boson Scattering

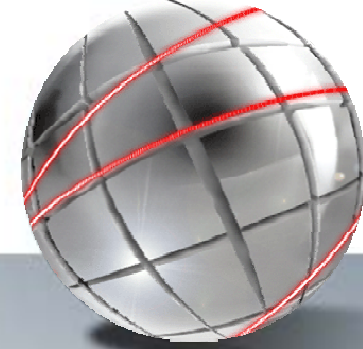
# GridUNESP

- High Energy Physics
- Lattice QCD
- High Tc Superconductivity
- Bioinformatics
- Genomics & Cancer Studies
- Protein Folding
- Molecular Biology
- Geological & Hydrographic Modeling
- Fluid Dynamics & Turbulence
- Numerical Methods in Mechanical Engineering.



Support  
MCT/Finep  
US\$ 2 M

# São Paulo State

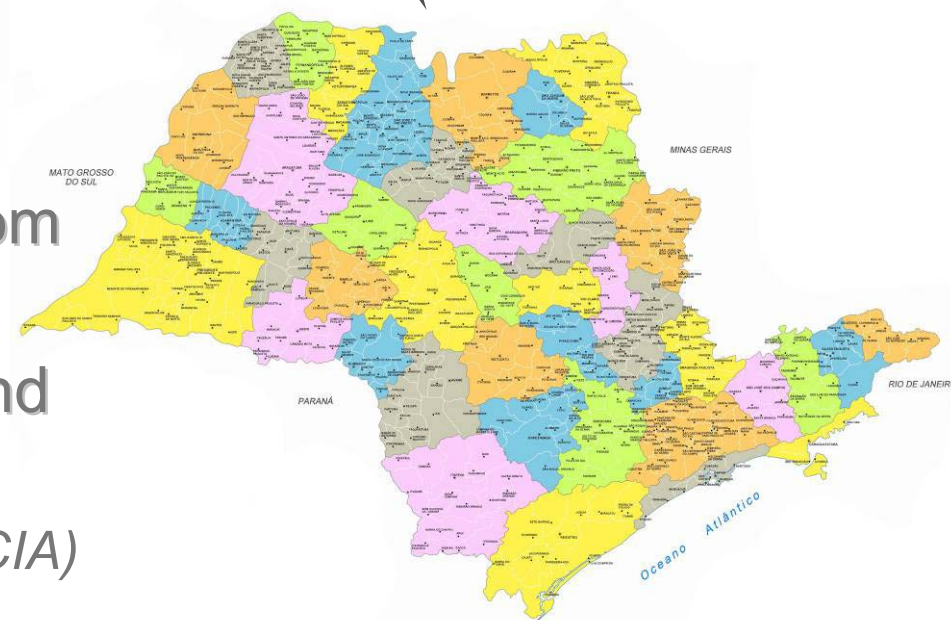


## 1/5 Brazilian Population

- 15 million Italians
- 7 million Portuguese and Spanish
- 5 million Lebanese & Syrians
- 4 million Asians
- 3 million Germanys

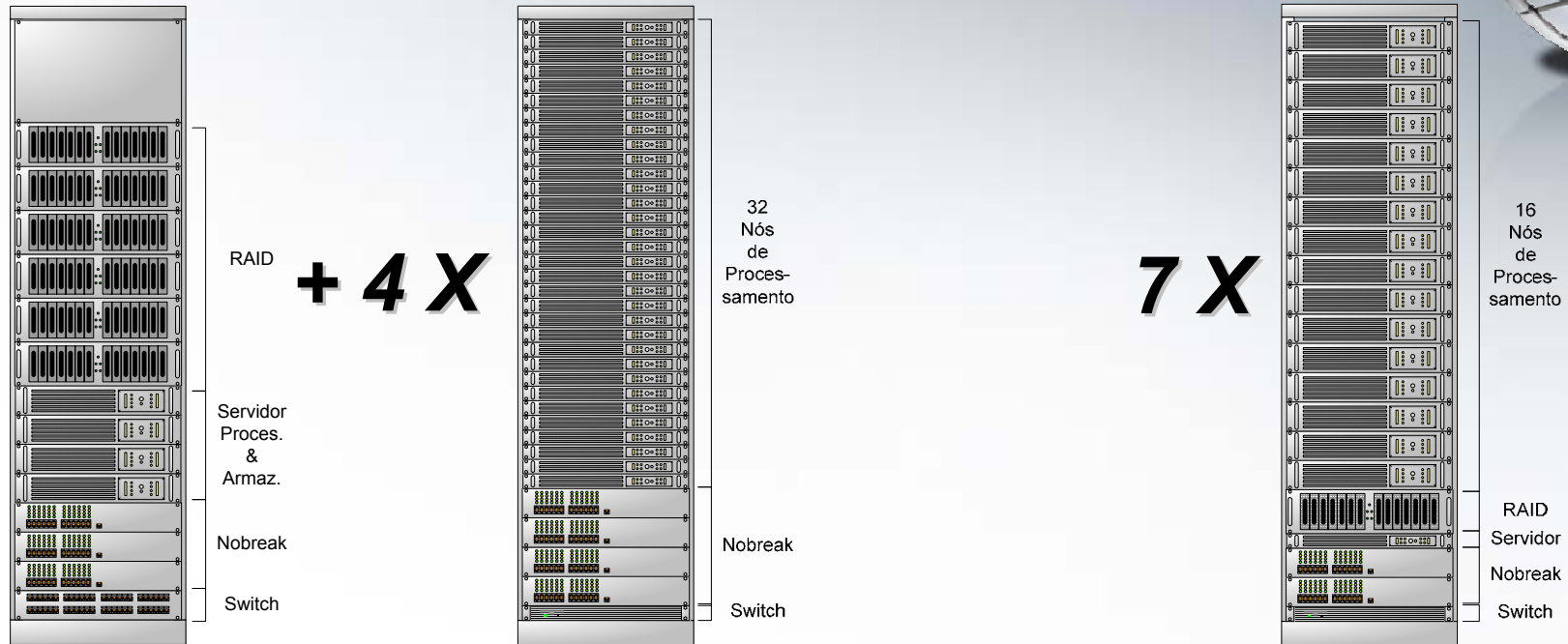
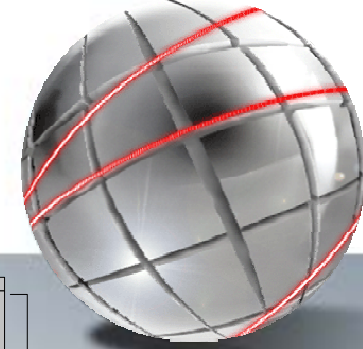
## 1/3 Brazilian Economy

Size (250K km<sup>2</sup>)      ≈ United Kingdom  
Population (40.5M)      ≈ Spain  
GDP/PPP (\$ 500B)      ≈ 2 X Switzerland



*The World Fact Book (CIA)*

# GridUNESP: 1,920 Processing Cores



## Central Cluster

1 Processing Server + 3 Storage Servers

128 two Quad Core Intel Xeon processor (InfiniBand)

RAID: 64 X 500 GB = 32 TB

## Distributed Clusters

1 Server

16 two Quad Core nodes

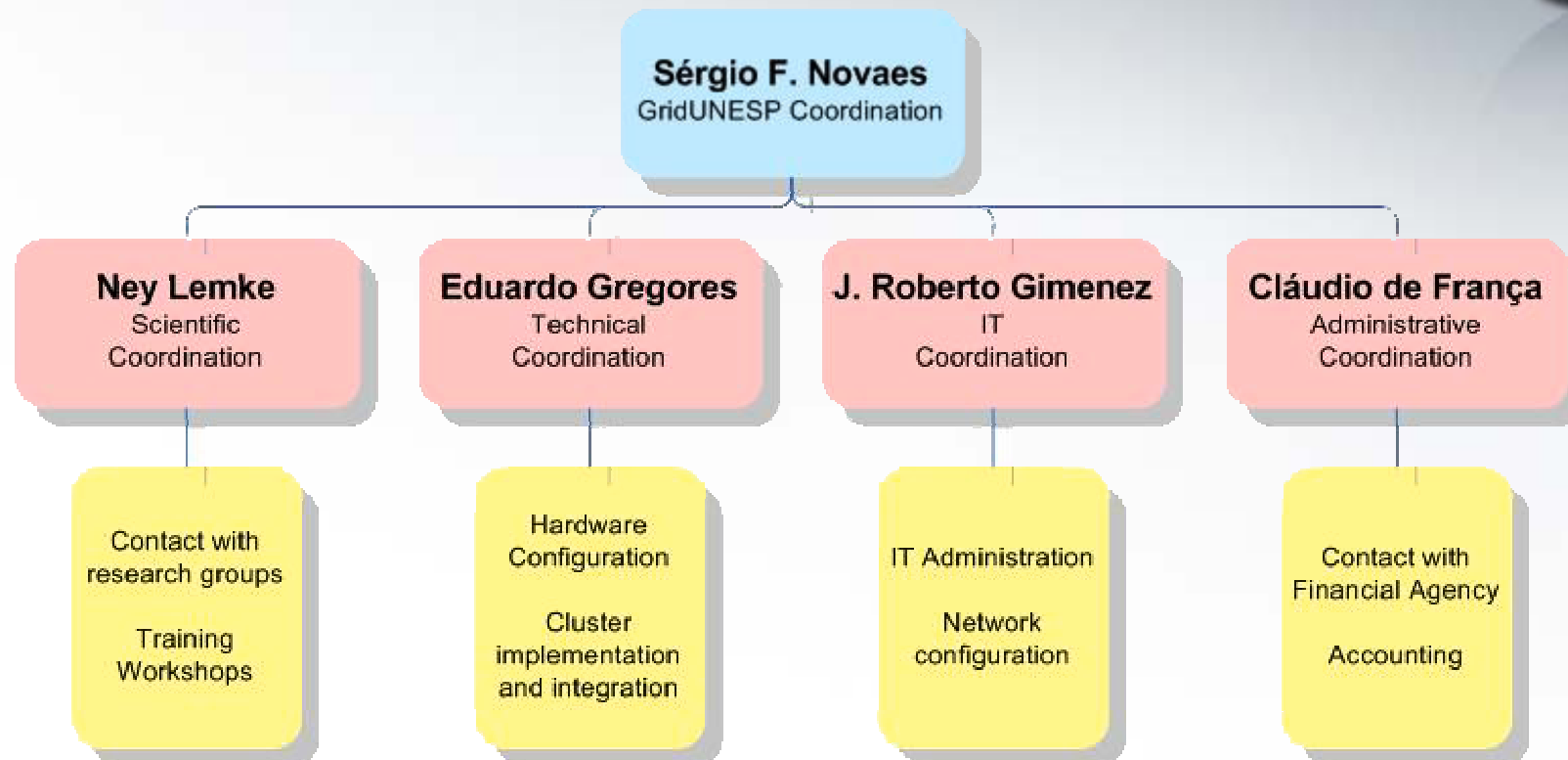
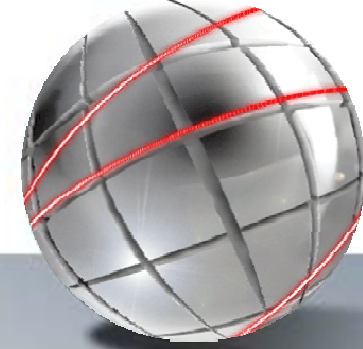
RAID = 4 TB



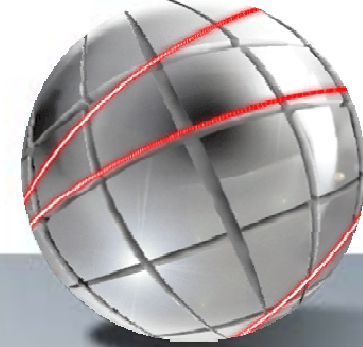
Programa de Integração da Capacidade Computacional da UNESP



# Organization Chart



# Timeline and Milestones

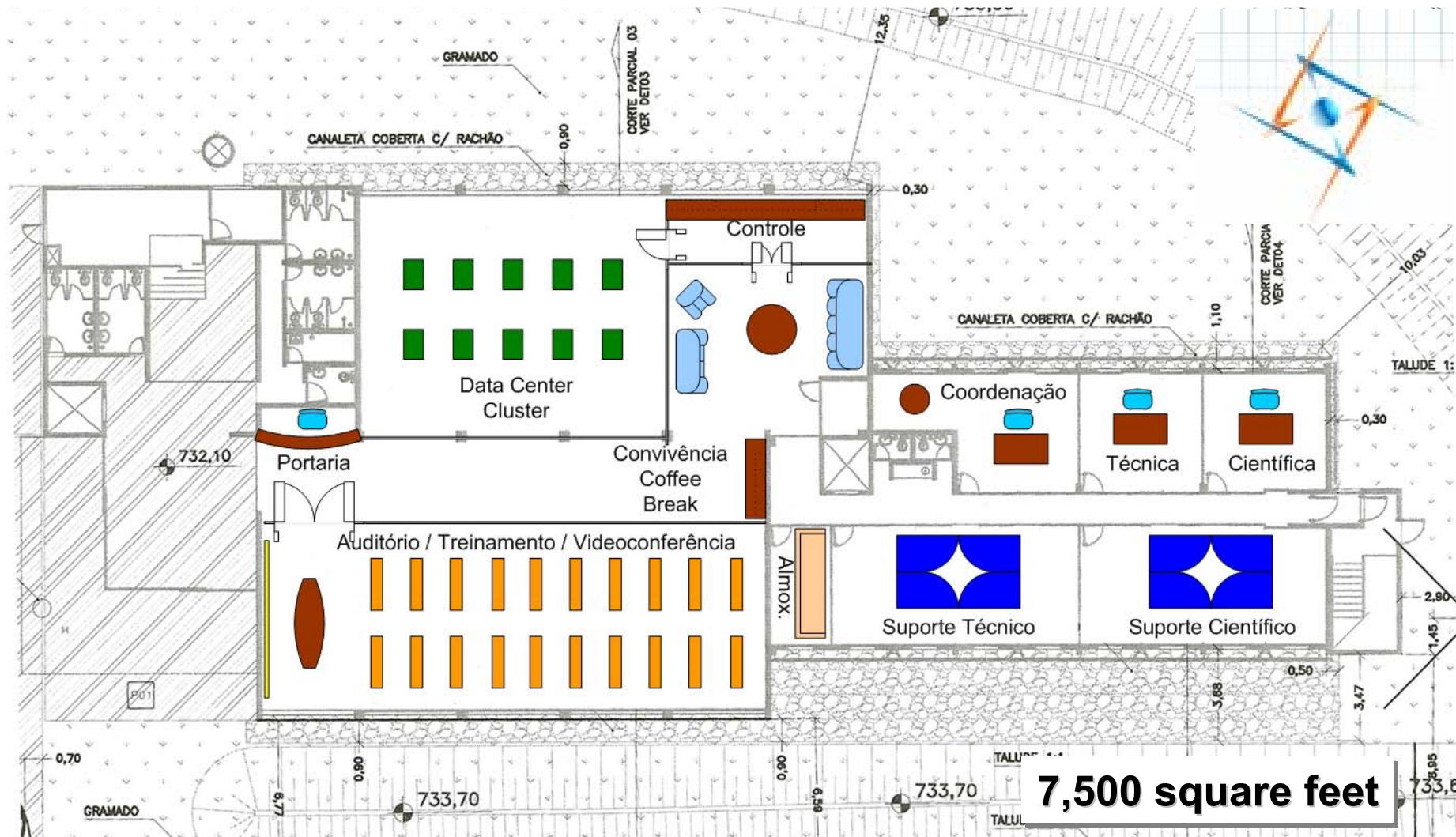


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Identify suppliers, promote the bid and buy hardware	█	█																							
Hardware delivery, installation, basic configuration (OS and network), and first tests			█	█																					
Integration of the local resources (NIS, NFS, Condor)					█	█																			
Grid integration of local clusters (Tier 0 and 1 certification and authentication)						█	█	█																	
Implementation of client services at the local clusters and tests of submission and monitoring							█	█	█	█	█														
GridUNESP VO registered at OSG. Administration services and Integration into the GridUNESP VO										█	█	█	█	█	█										
Integration of Local clusters (Tiers 1) in the GridUnesp VO and user certification. Test job submission.														█	█	█	█	█	█	█					
Development of interface (Portal) for the research group application to run their jobs in GridUNESP																	█	█	█	█	█	█	█	█	█



Programa de Integração da Capacidade Computacional da UNESP

# Data Center Floor Plan



# Challenges



- The implementation the physical infrastructure is the first and easiest step.
- The real challenge is to make GridUNESP a really useful infrastructure for all the research groups of the university:
  - Deploy a network connection compatible with the Grid requirements
  - Provide 24/7 support to the system
  - Provide training to the system managers and researchers
  - Implement a portal for job submission
  - Provide permanent support to users
  - Incorporate new computing resources

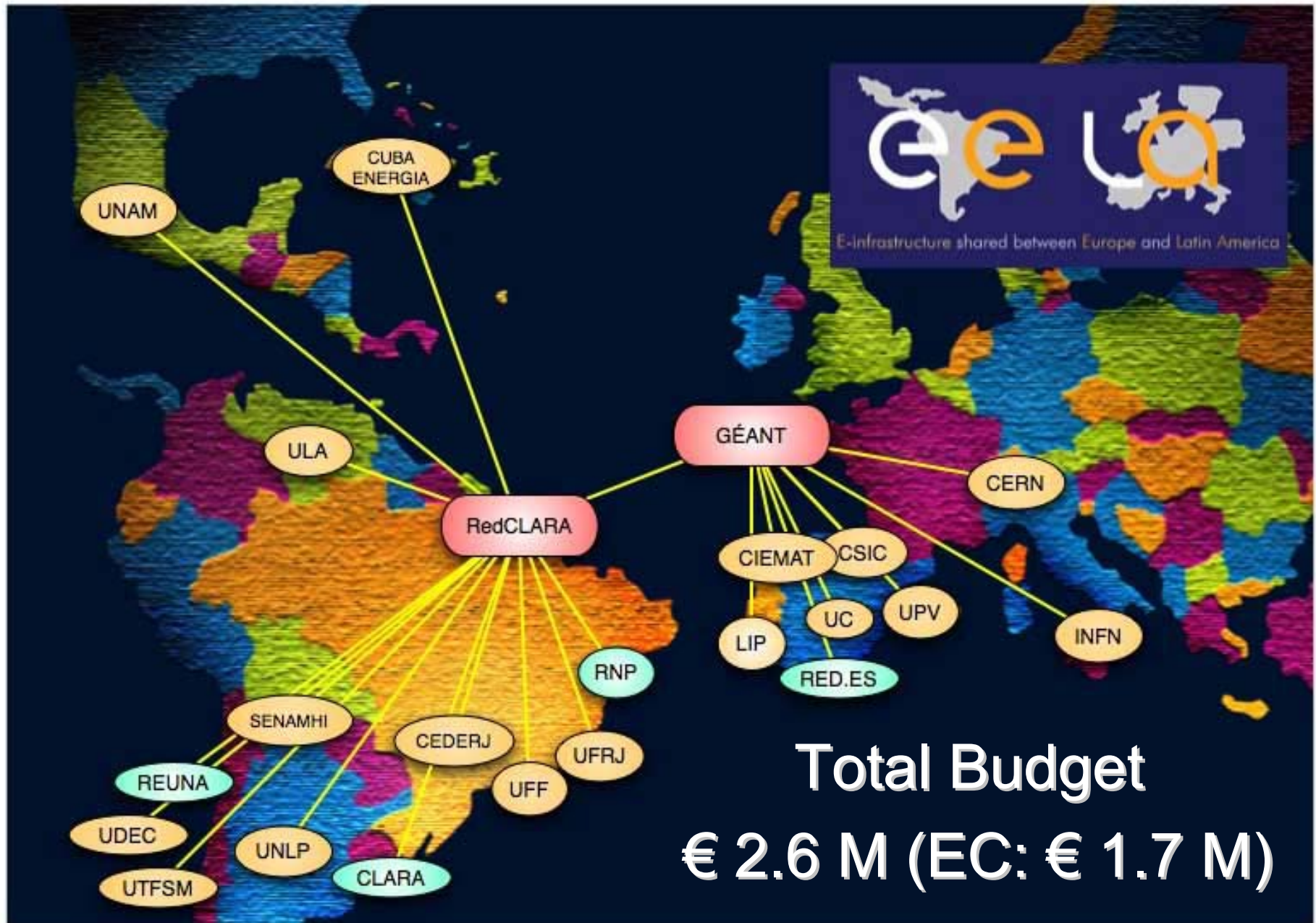
# ***E-Infrastructure shared between Europe and Latin America (EELA)***



- **Purposes:**

- Bridge consolidated e-Infrastructure initiatives in Europe and emerging ones in LA and establish a collaborative network
  - Set up the structure for collaboration network
  - Implement support mechanisms
  - Establish policies for sharing the e-Infrastructure
  - Identify new areas of collaboration and partners, both in Europe and LA
- Help to leverage e-Infrastructure in Latin America
  - Implement basic mechanisms for an interoperable e-Infrastructure
  - Set up a testbed, establish VO's and support developers and users
- Promote a sustainable framework for e-Science in LA
  - Identify research communities and applications
  - Support dissemination efforts
  - Define a roadmap for a consolidated e-Infrastructure in LA

# EELA Partners & Budget



# 2008: EELA-2 (Budget = € 4 – 5 M)

- **Participating countries**
  - Europe:  
France, Italy, Portugal, Spain
  - Latin America:  
Argentina, Brazil, Chile, Colombia, Cuba, Ecuador, Mexico, Peru, Uruguay, Venezuela
- **Networking Activities**
  - Management of the IP
  - Dissemination and Community Building
  - Training
    - Set-up and Management of a training infrastructure and material repository
    - Delivery of training and induction courses
  - Application and Community Support
    - Support for Bio-medicine, Climate, e-Education, Earth Science, Physics, e-Government communities
- **Joint Research Activities**
  - Development of Services for Applications
    - Middleware interoperability
    - Applications' requirements collection
    - Development of Grid and Network Services for Applications
- **Service Activities**
  - Grid Operations, Support and Management
    - Management and coordination
    - Grid Deployment, Site Certification and Operations
    - Users' Support, including VO Services
  - Network Resource Provision
    - Overall networking coordination
    - Network Operations Centre
    - End-to-end Service Level Agreements
    - Liaison with Network Providers

# ***What about a similar initiative from OSG?***

- Bridge e-Infrastructure initiatives in US and Latin America

  - Establish support mechanisms for LA initiatives

  - Promote exchange of experts / developers / users

  - Provide training for newcomers

  - Identify research communities and applications

  - Promote the OSG framework for e-Science in Latin America

- How we could help:

  - Look for joint financial support, e.g. NSF-FAPESP partnership

  - Identify partners in the IT industry for hardware deployment

  - Identify new communities and applications for sharing the e-Infrastructure

  - Implement the necessary infrastructure for training: Educational Grid

  - Gather talented students through a Grid training program

  - Organize a Summer Grid School in Brazil (inauguration of GridUNESP?)