

# GRID COMPUTING CENTER OF THE AMERICAS

## Workshop

February  
**8-10**

UNAM, Mexico City

### Organizing Committee:

- Ignacio Anis, DGTIC-UNAM
- Alejandro Ayala, ICN-UNAM
- Federico Carminati, CERN
- Luciano Diaz, ICN-UNAM
- Oscar Fernández, DGTIC-UNAM
- Alejandro Frank, ICN-UNAM
- Haeng Jin Joo, KISTI
- Lukas Nellen, ICN-UNAM
- Guy Paic, ICN-UNAM
- Lawrence Pinsky, LBL
- Jeff Porter, LBL

DISCUSSION ABOUT THE CREATION OF A GRID  
COMPUTING AND DATA CENTER IN UNAM  
**DEVELOPMENT OF A T1 PROTOTYPE FOR THE ALICE EXPERIMENT**

# Development of GRID in Brazil



**A. Santoro**  
DFNAE/UERJ/RIO  
Mexico – February 8 - 10 2011

México with a Tier 1 Whorkshop

## Outline:

### **I - Introduction**

- History
- Digital Divide

### **II - GRIDs On HEP in Brazil**

### **III - Conclusion**



# HIGH ENERGY PHYSICS GRID

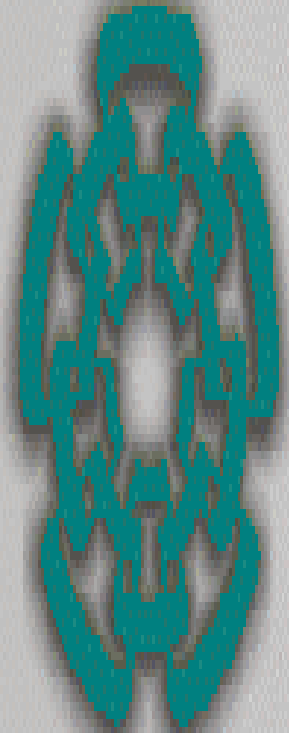
Cinvestav, Mexico – April 5<sup>th</sup>, 2005

Alberto Santoro

## Outline

- Introduction – Definitions
- Organization of the HEPGrid Projects
  - Computing Model – LHC Data Grid Hierarchy
  - iVDGL + GryPhyN + PPDG = Trilling
  - ii) GRID for Alice, Atlas, LHCb, CMS
  - iii) Other GRID Projects
- Conclusion

Cinvestav



# Digital Divide in Latin America

**Alberto Santoro**  
**UERJ/Brazil**

**International ICFA Workshop on Digital Divide Issues for Global e-Science**  
**México City, October 24-27, 2007**

**I would like to dedicate my talk to David Williams  
a very good friend!**

# Outline

# I - Introduction

## II - Some Information about L.A. on Network Developments

### III - HEPGRID Brasil- UERJ

## IV - Conclusion

***ICFA/SCIC/DD=International Committee for Future Accelerators/  
Standing Committee on International Connectivity/Digital Divide***

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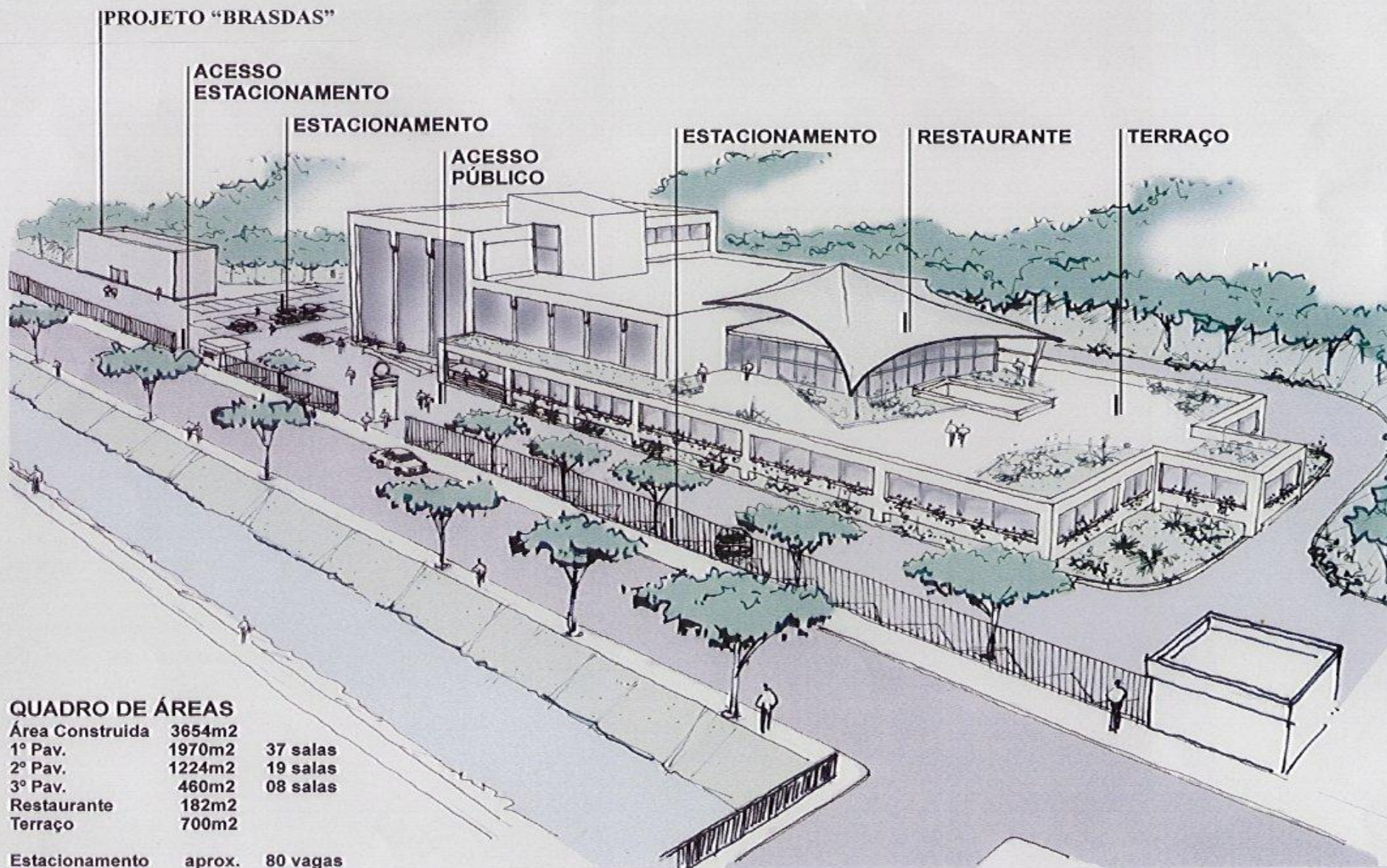
# I - Introduction/History

- I will limit my talk in HEP Brazilian initiatives.
- There are lots of other initiatives that are good but not fit with our needs in HEP and for this meeting.
- This does not means that other areas can not run in our cluster. We have in all Brazilian Tier2 running jobs from other collaborations and other branches of science.
- While GRID is a solution for Computing in High Energy Physics, Digital Divide is a major drawback to the progress of our Science.



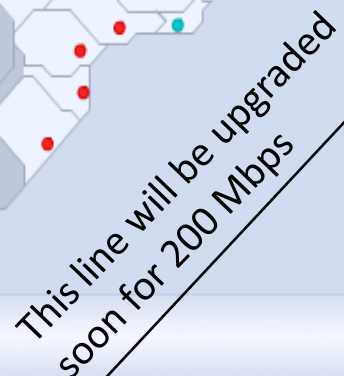
# History

Why we are in this business?



And the Network?

## A INICIATIVA



**Redecomep** é uma iniciativa do Ministério da Ciência e Tecnologia (MCT), coordenada pela Rede Nacional de Ensino e Pesquisa (RNP), que tem como objetivo implementar redes de alta velocidade nas regiões metropolitanas do país servidas pelos Pontos de Presença da RNP. O modelo adotado baseia-se na implantação de uma infra-estrutura de fibras ópticas própria voltada para as instituições de pesquisa e educação superior e na formação de consórcios entre as instituições participantes de forma a assegurar sua auto-sustentação.

## Redecomep em números

Cidades que já assinaram o Memorando de entendimentos (MoU)	27
Cidades que já estão implantando a rede	6
Cidades que concluíram a implantação da rede	21
Instituições participantes	290
Investimento em fibra própria até o momento (estimado)	R\$7 milhões
Investimento em equipamentos até o momento (estimado)	R\$5 milhões
Estimativa de cobertura	1650 Km

## ETAPAS

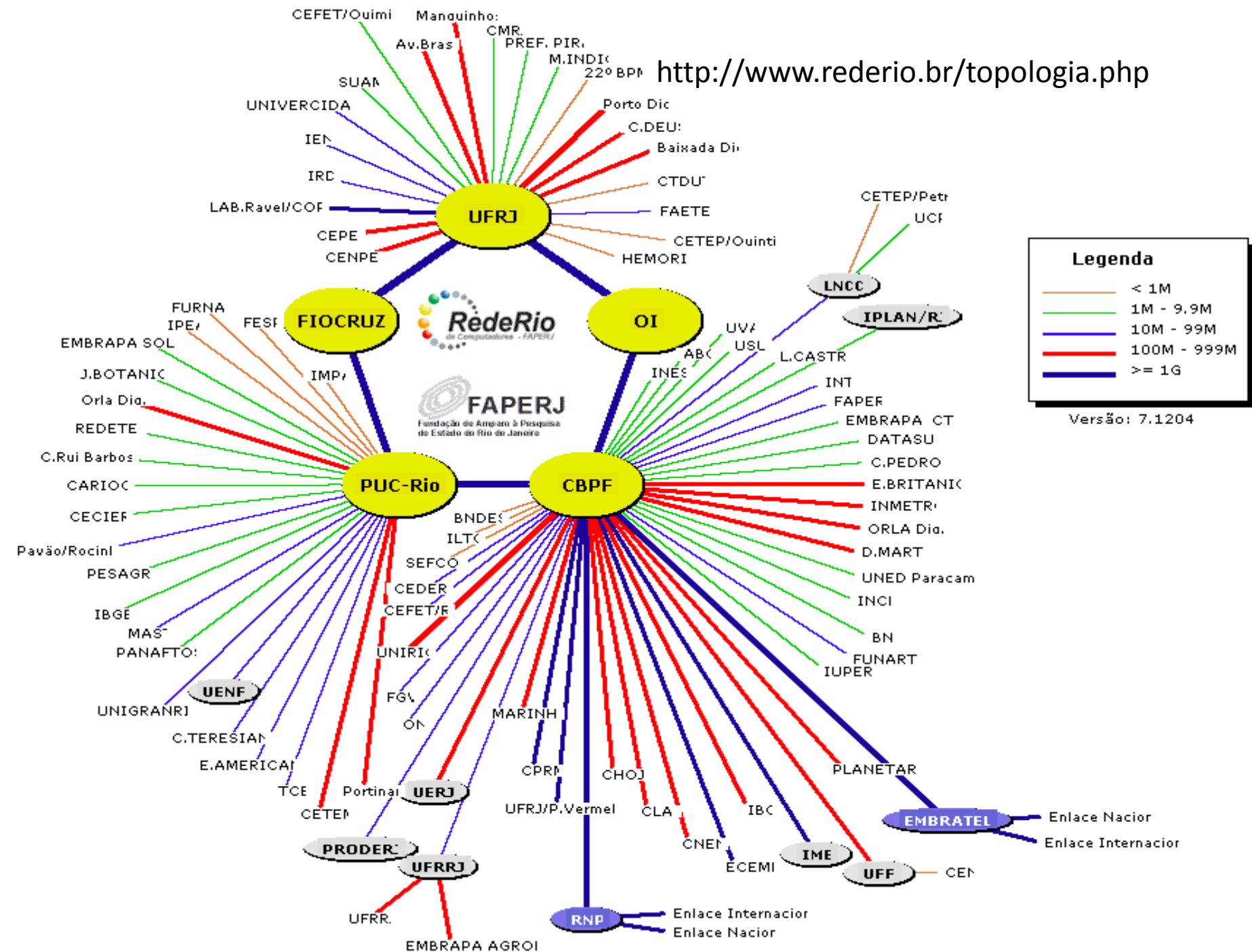
- 1) Criação do comitê gestor
- 2) Início da implantação
- 3) Construção da rede
- 4) Aquisição de equipamentos e cabos ópticos
- 5) Aceitação e teste dos serviços e equipamentos
- 6) Implantação da rede lógica
- 7) Interligação da rede ao backbone da RNP

## DESTAQUES

- 25/01/11 – Notícias  
Boletim Redecomep - retrospectiva 2010
- 27/12/10 – Notícias  
Boletim Redecomep
- 17/11/10 – Notícias  
Boletim Redecomep
- 29/10/10 – Notícias

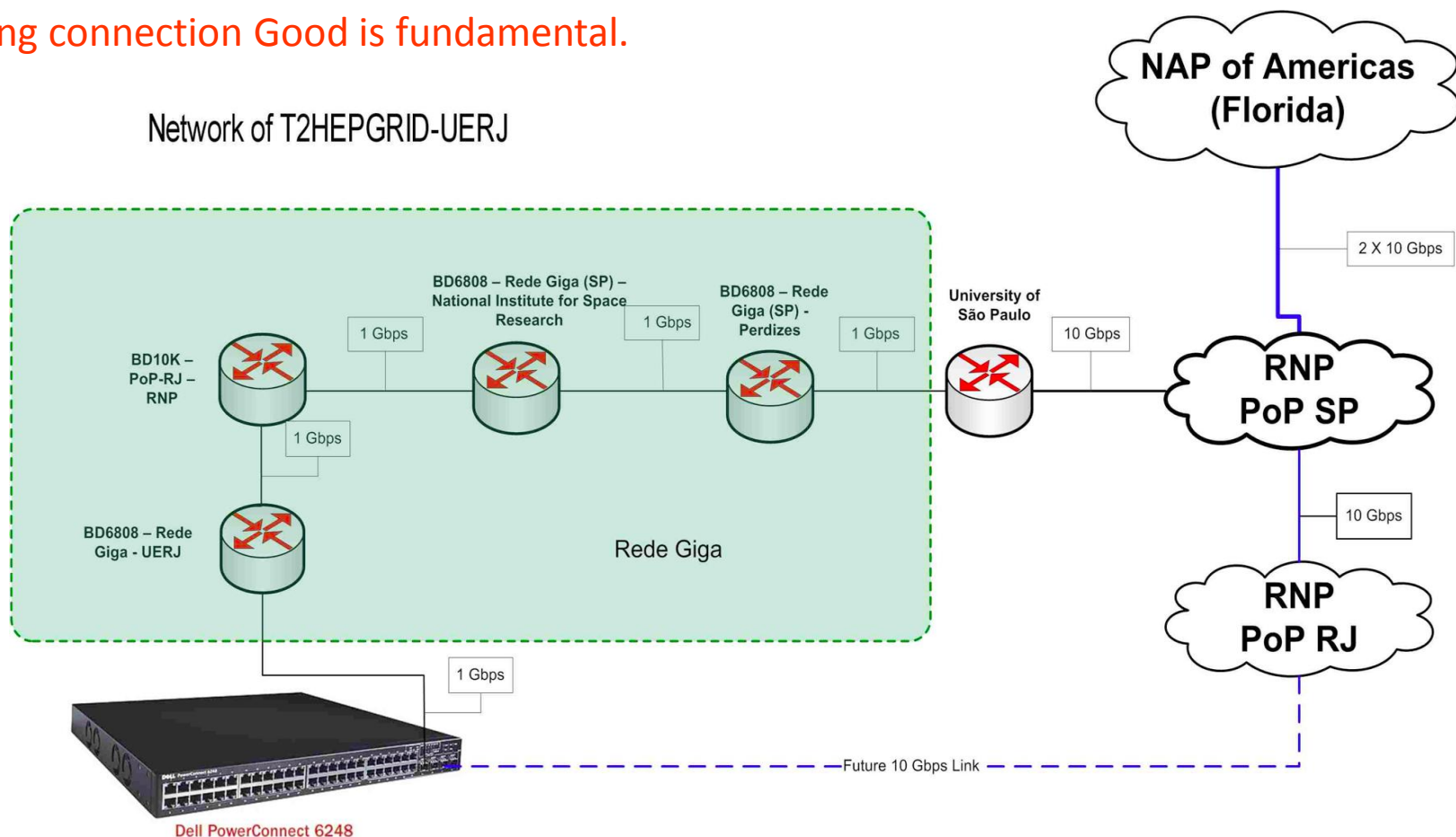


<http://www.rederio.br/topologia.php>

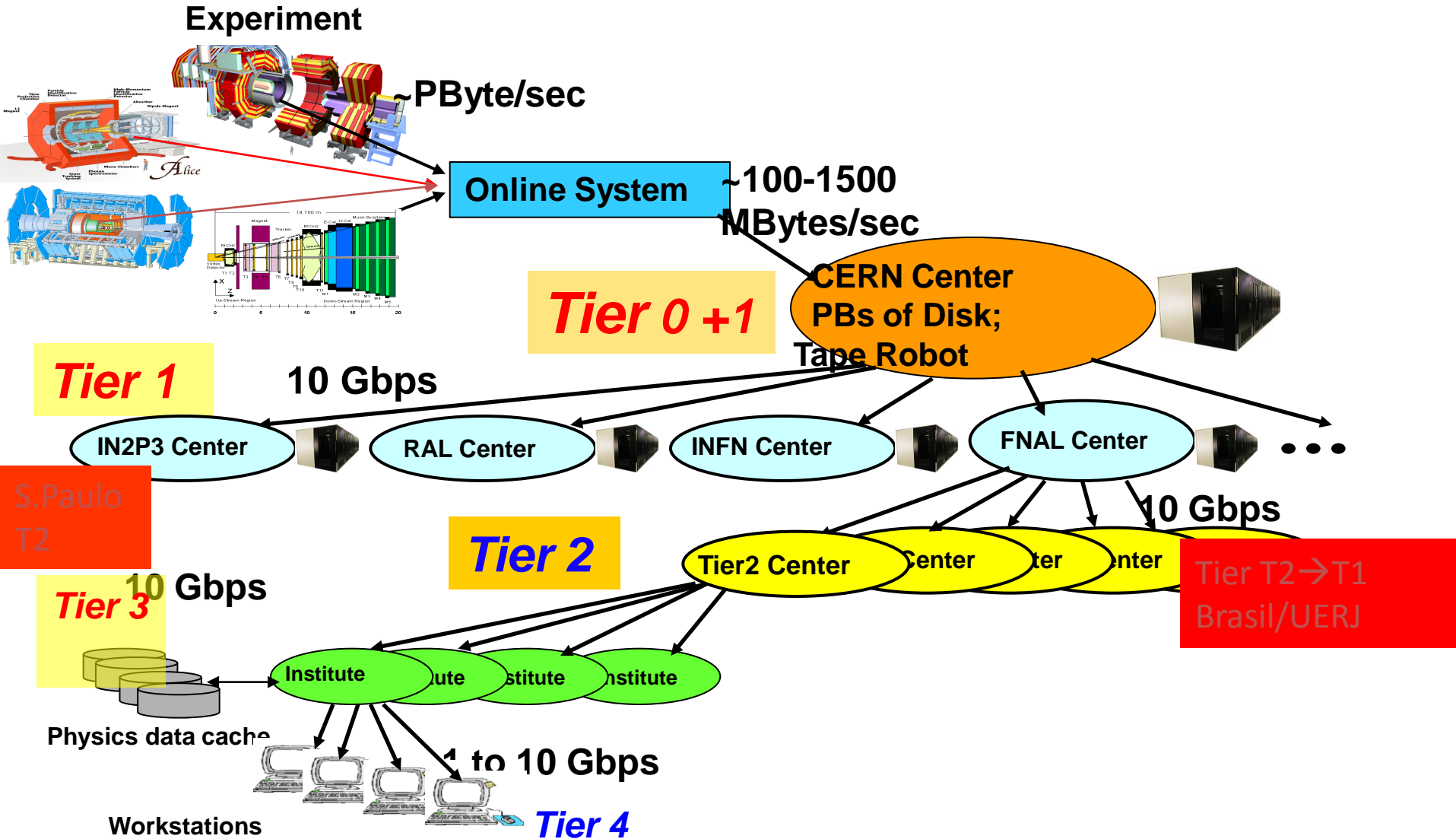


We have to pay attention to the local Digital Divide. To work together with local Network. Connectivity is one of the main elements of the GRID.

Short and long connection Good is fundamental.

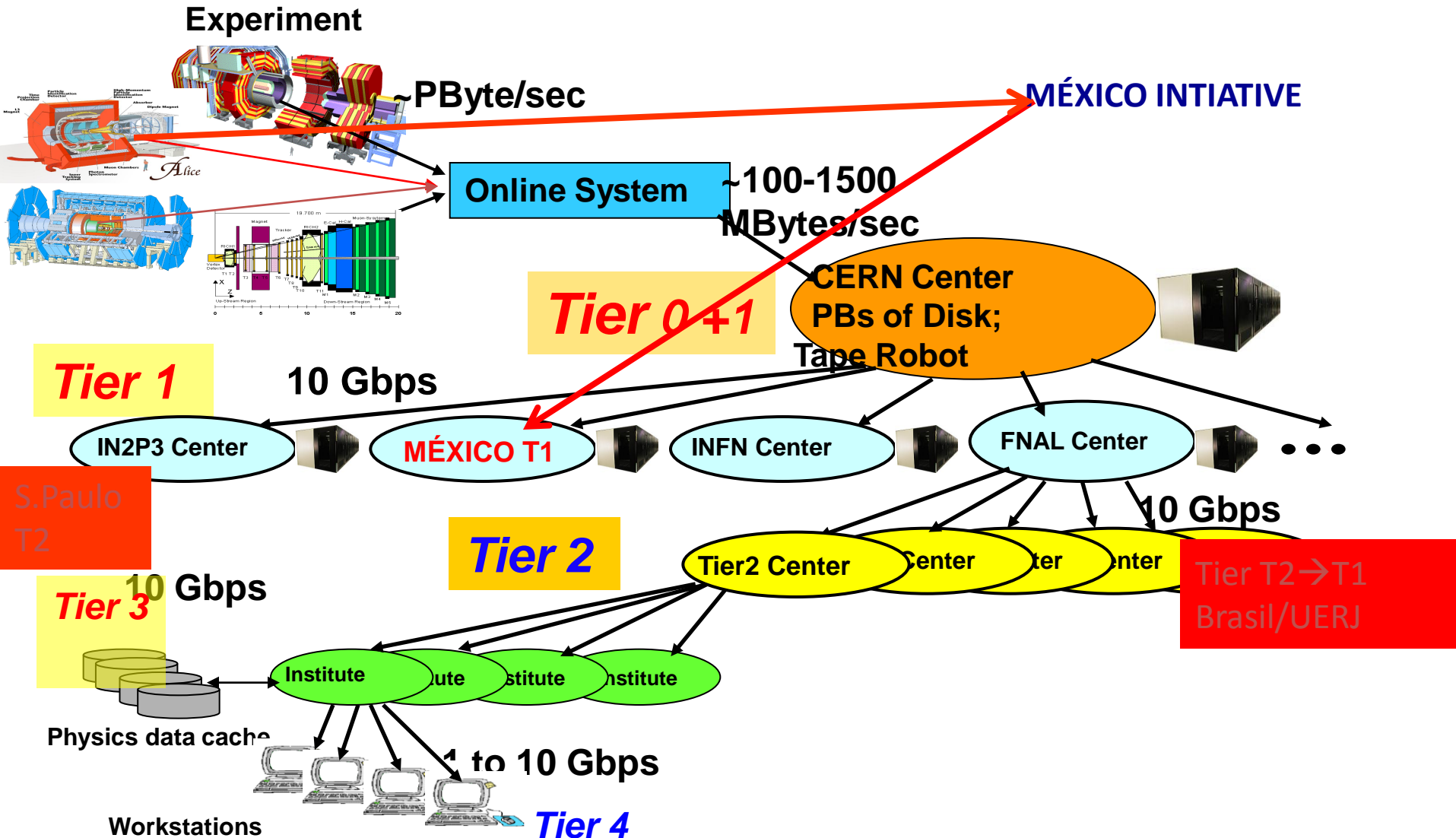


# LHC Data Grid Hierarchy





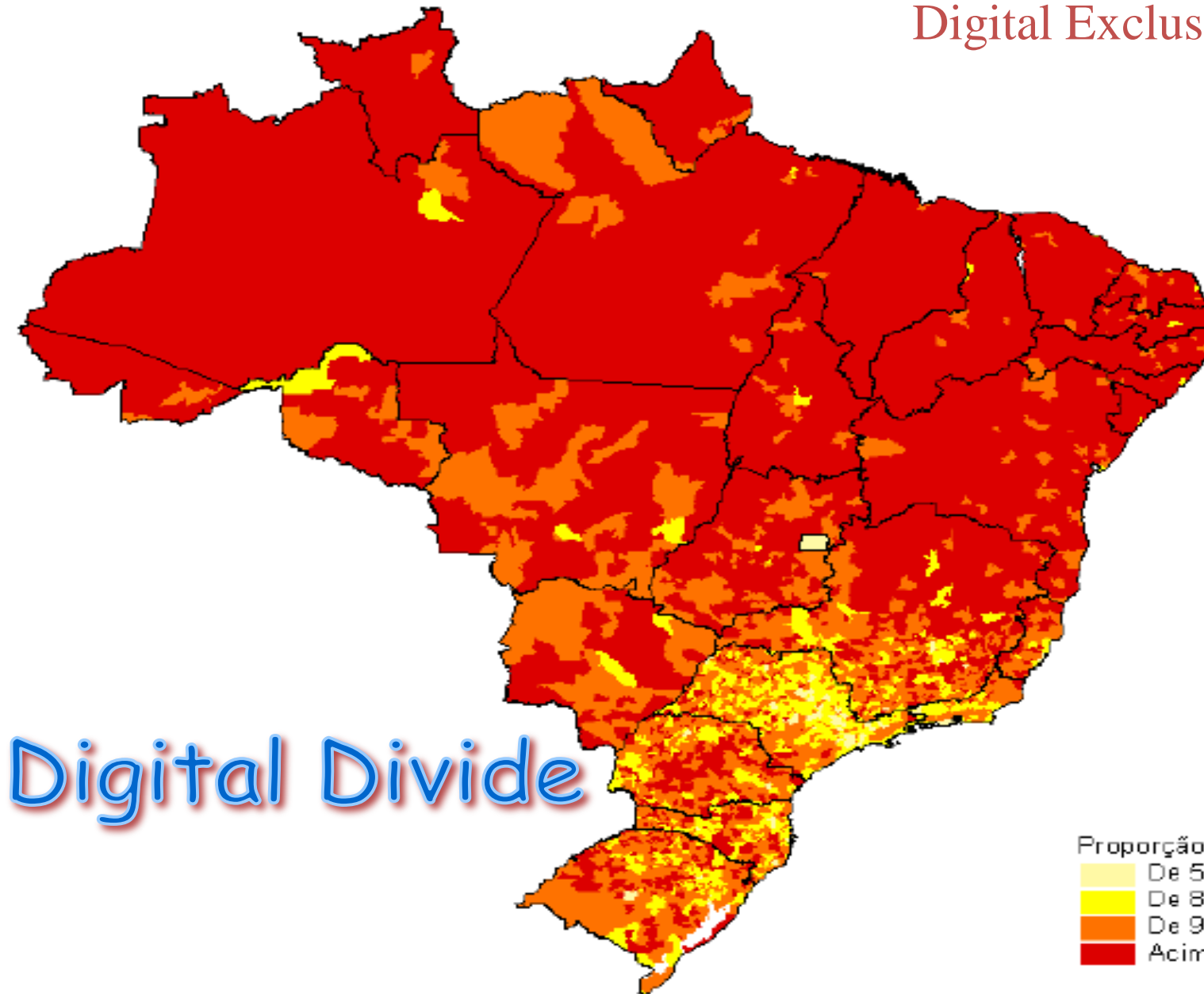
# LHC Data Grid Hierarchy



Let us show a bit about Digital Divide

# MAPA DA EXCLUSÃO DIGITAL

Digital Exclusion Map



Proporção

- De 59% a 84% excluídos
- De 84% a 92% excluídos
- De 92% a 97% excluídos
- Acima de 97% excluídos

Digital Divide



# Digital Divide view by the boys from Primary School

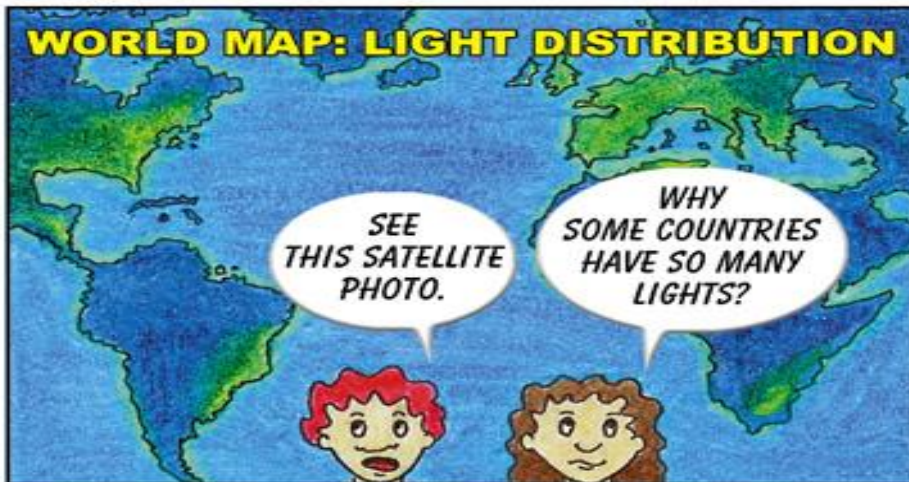
Brazil has less than ?? (was 5 years ago 4%) of the Population using Internet

190 M habitants and only 7 M access the Internet but everybody has Celphone





## WORLD MAP: LIGHT DISTRIBUTION





Now the situation is much better





## RedCLARA Connectivity to Participating Networks

[http://www.redclara.net/index.php?option=com\\_content&task=view&id=51&Itemid=236](http://www.redclara.net/index.php?option=com_content&task=view&id=51&Itemid=236)

**I call this the Digital Divide**

Latin America Country	NREN Organization	RedCLARA Connectivity (Mbps)
<b>Argentina</b>	<b>INOVARED</b> <a href="http://www.inovared.org.ar">www.inovared.org.ar</a>	<b>210</b>
<b>Bolivia</b>	<b>ADSIB</b> <a href="http://www.bolnet.bo">www.bolnet.bo</a>	<b>(64-128 )x 10<sup>-3</sup></b>
<b>Brazil</b>	<b>RNP</b> <a href="http://www.rnp.br">www.rnp.br</a>	<b>1,450</b>
<b>Chile</b>	<b>REUNA</b> <a href="http://www.reuna.cl">www.reuna.cl</a>	<b>1,000</b>
<b>Colombia</b>	<b>RENATA</b> <a href="http://www.renata.edu.co">www.renata.edu.co</a>	<b>150</b>
<b>Costa Rica</b>	<b>CR2Net</b> <a href="http://www.crnet.cr/cr2net/">www.crnet.cr/cr2net/</a>	<b>155</b>
<b>Cuba</b>	<b>RedUniv</b> <a href="http://www.mes.edu.cu">www.mes.edu.cu</a>	<b>2</b>
<b>Ecuador</b>	<b>CEDIA</b> <a href="http://www.cedia.org.ec">www.cedia.org.ec</a>	<b>45</b>
<b>El Salvador</b>	<b>RAICES</b> <a href="http://www.raices.org.sv">www.raices.org.sv</a>	<b>10</b>
<b>Guatemala</b>	<b>RAGIE</b> <a href="http://www.ragie.org.gt">www.ragie.org.gt</a>	<b>18</b>
<b>Honduras</b>	<b>HONDUNET</b> <a href="http://www.unitec.edu">www.unitec.edu</a>	<b>unknown</b>
<b>México</b>	<b>CUDI</b> <a href="http://www.cudi.edu.mx">www.cudi.edu.mx</a>	<b>45 (155→1Gbps→10Gbps???)</b>
<b>Nicaragua</b>	<b>RENIA</b> <a href="http://www.renia.net.ni">www.renia.net.ni</a>	<b>100</b>
<b>Panama</b>	<b>PANNET/SENACYT</b> <a href="http://www.redcyt.org.pa">www.redcyt.org.pa</a>	<b>10</b>
<b>Paraguay</b>	<b>ARANDU</b> - unknown url	<b>unknown</b>
<b>Peru</b>	<b>CONCYTEC</b> <a href="http://www.raap.org.pe">www.raap.org.pe</a>	<b>14</b>
<b>Uruguay</b>	<b>RAU</b> <a href="http://www.rau.edu.uy/redavanzada">www.rau.edu.uy/redavanzada</a>	<b>100</b>
<b>Venezuela</b>	<b>REACCIUN</b> <a href="http://www.reacciun2.edu.ve">www.reacciun2.edu.ve</a>	<b>90</b>

## INTERNET USERS AND POPULATION STATS FOR THE AMERICAS

<u>REGION</u>	Population ( 2010 Est. )	% Pop. America	Internet Users, Latest Data	% Population ( Penetration )	User Growth ( 2000-2010 )	% Users America
<a href="#">North America</a>	344,124,450	36.7 %	266,224,500	77.4 %	146.3 %	56.5 %
<a href="#">South America</a>	396,626,130	42.3 %	156,609,436	39.5 %	995.8 %	33.3 %
<a href="#">Central America</a>	154,298,120	16.5 %	38,433,400	24.9 %	1,094.5 %	8.2 %
<a href="#">The Caribbean</a>	41,632,722	4.4 %	9,647,000	23.2 %	1,624.5 %	2.0 %
<b>TOTAL AMERICAS</b>	936,681,422	100.0 %	470,914,336	50.3 %	273.3 %	100.0 %
<a href="#">All the Americas</a>	936,681,422	13.7 %	470,914,336	50.3 %	273.3 %	23.9 %
<a href="#">Rest of the World</a>	5,908,928,538	86.3 %	1,495,600,480	25.3 %	536.9 %	76.1 %
<b>WORLD TOTAL</b>	6,845,609,960	100.0 %	1,966,514,816	28.7 %	444.8 %	100.0 %

### Mexico Country Area:

1,967,328 sq km - Population density: 57 persons per sq km

### Internet Usage and Population Growth:

YEAR	Users	Population	% Pen.	Usage Source
2000	2,712,400	98,991,200	2.7 %	<a href="#">ITU</a>
2004	14,901,687	102,797,200	14.3 %	<a href="#">AMIPCI</a>
2005	17,100,000	103,872,328	16.3 %	<a href="#">AMIPCI</a>
2006	20,200,000	105,149,952	19.2 %	<a href="#">AMIPCI</a>
2008	27,400,000	109,955,400	24.9 %	<a href="#">eMarketer</a>
2010	30,600,000	112,468,855	27.2 %	<a href="#">AMIPCI</a>

# Digital Divide on World Economic Forum:

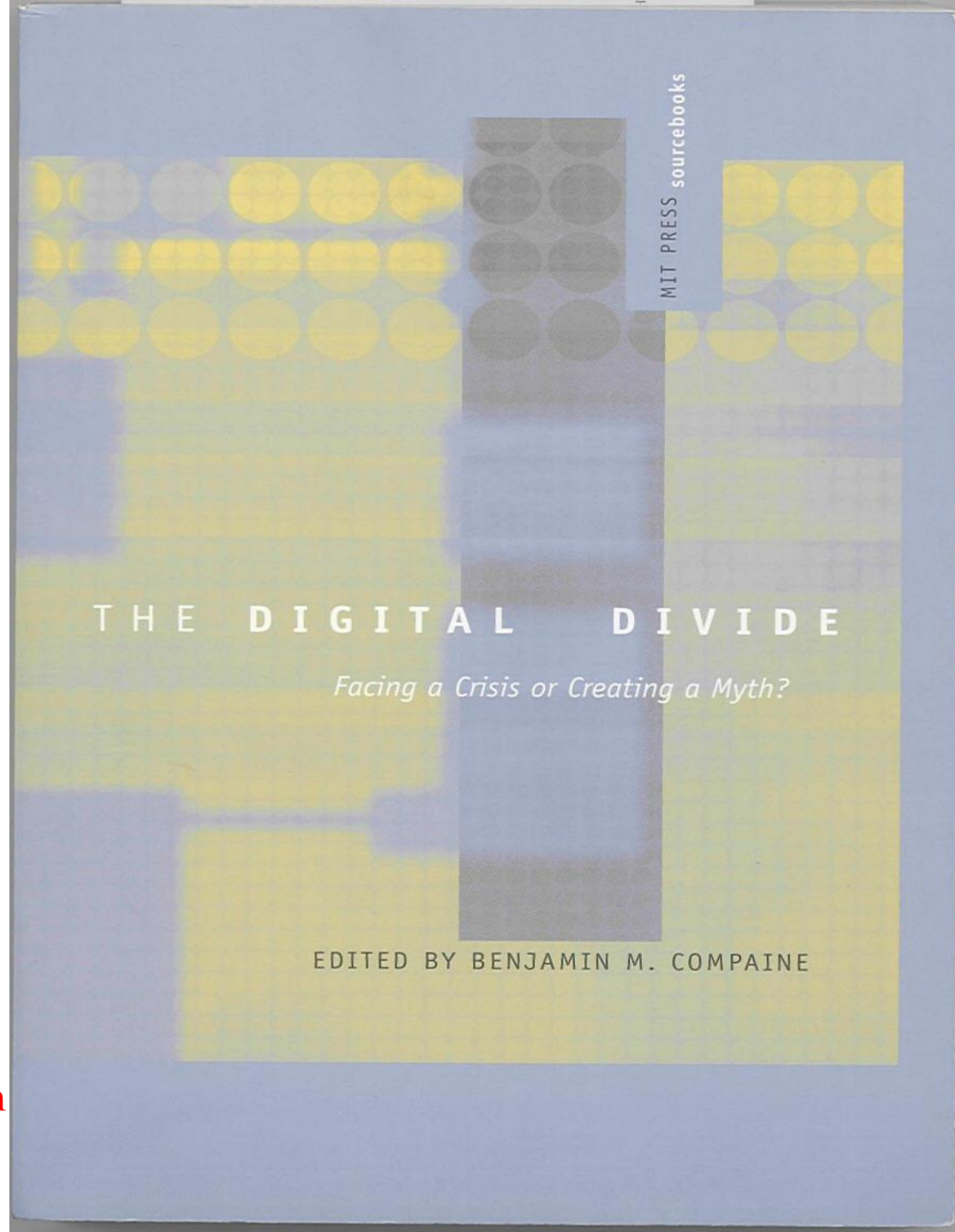
<http://www.weforum.org/site/homepublic.nsf/Content/Global+Digital+Divide+Initiative>

FROM THE GLOBAL  
DIGITAL DIVIDE TO THE  
GLOBAL DIGITAL  
OPPORTUNITY

PROPOSALS  
SUBMITTED TO THE  
G-8 KYUSHU-OKINAWA  
SUMMIT 2000

TOKYO, JAPAN  
19 JULY

[http://www2.fgv.br/ibre/cps/mapa\\_exclusao/apresentacao/apresentacao.htm](http://www2.fgv.br/ibre/cps/mapa_exclusao/apresentacao/apresentacao.htm)



# To face the problems with Digital Divide ICFA take some initiatives



## ICFA-SCIC

International Committee on Future Accelerators  
Standing Committee on Interregional Connectivity

<http://icfa-scic.web.cern.ch/ICFA-SCIC/>



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### Mission Statement

**To monitor and review interregional connectivity, high energy physics requirements  
and make recommendations for network improvements**

#### 2010 ICFA Documents

[SCIC Presentation to ICFA by Harvey Newman](#) - Feb/2010 [43MB]

[Main HENP Report to ICFA by Harvey Newman](#) - Feb/2010 [3MB]

[Annexes to the ICFA Report](#) - Harvey Newman - Feb/2010 [18MB]

[Network Monitoring Report](#) - Les Cottrell - Feb/2010 [7MB]

#### 2009 ICFA Documents

[SCIC Presentation to ICFA by Harvey Newman](#) - Feb/2009 [50MB]

[Main HENP Report to ICFA by Harvey Newman](#) - Feb/2009 [10MB]

[Annexes to the ICFA Report](#) - Harvey Newman - Feb/2009 [13MB]

[Network Monitoring Report](#) - Les Cottrell - Feb/2009 [11MB]



# II- GRIDS on HEP in Brazil

GRID MEANS: The best combination of:

- Share CPU Power
- Share Data Storage
- High Bandwidth, Speed Networks

} Technologies are available to  
Go ahead on these two parts

- Networks has been the big bottleneck in our HEPGRID projects.
- Price of Machines are too high 2 to 3 times more than in USA and EU of bandwidths.

We have three working Tier 2 in Brazil:

**At CBPF – Mainly dedicated to LHCb -**

At UNESP:

SPRACE: mainly dedicated to CMS

CAMPUS UNESP: It is not a HEPGRID.

At UERJ: The T2-HEPGRID-Brasil-UERJ

There are many other initiatives in HEP and in other branches of Science.

# SPRACE



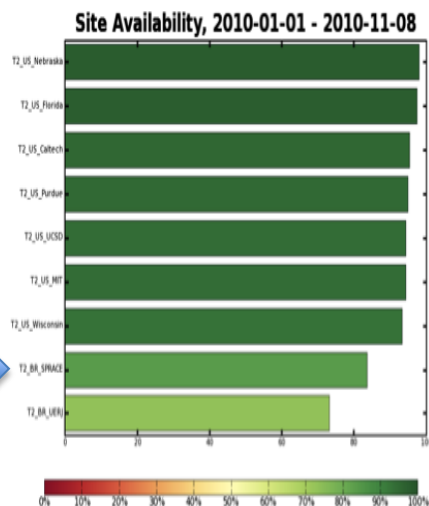
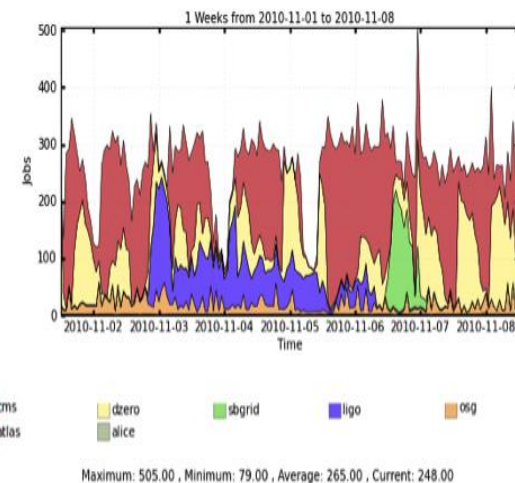
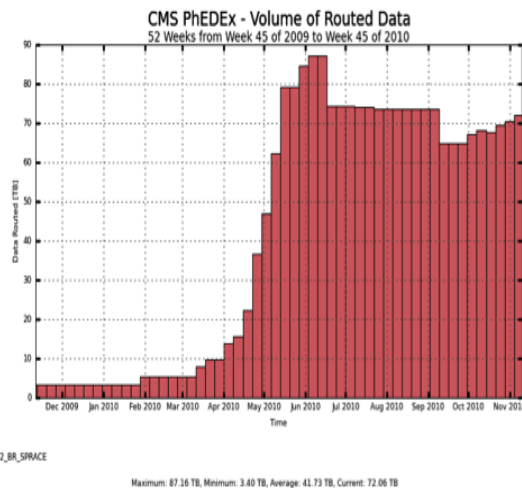
- Hosted in the Scientific Computing Nucleo of Unesp.
- Member of the – WLCG and OSG
- Operation shared with GridUnesp.
- Short Description:
  - Core (Batch Slots): 320
  - Memory/Node: 1,8 Gb
  - 7 Servers
  - Storage: 120 TB
  - Conectivity:
    - CERN: 5 Gbps
    - Kyatera Network: 10 Gb



# SPRACE



- Data Transfer : Phedex
- 70 TB transfer / week
- Other V.O. Use SPRACE
- Average of 300 jobs simultaneous
- CMS in red



- Working very well and among the best of the world.
- 30% of all production of ALPGEN from CMS.

# CBPF Tier 2 – (mainly dedicated to LHCb)

## GRID - CBPF

The main purpose of the GRID-CBPF is Simulation of Events of the Experiments of LHCb and CMS inside of the LCG project.

The operations started in August 2008.

At CBPF there are 3 persons with full dedication to this GRID

Now GCBPF count with 344 Cores and more 128 for soon  
Storage: 24 TB and 120 for soon

It is use the Glite Sistem developed by LCG

The CBPF-GRID make part of the ROC\_LA (Resource Operator Center).



These are the power of CBPF-GRID

Brazil Normalised CPU time (kSI2K) by SITE and VO.

ALL VO's. November 2008 - January 2011.

The following table shows the distribution of Normalised CPU time (kSI2K) grouped by SITE and VO.

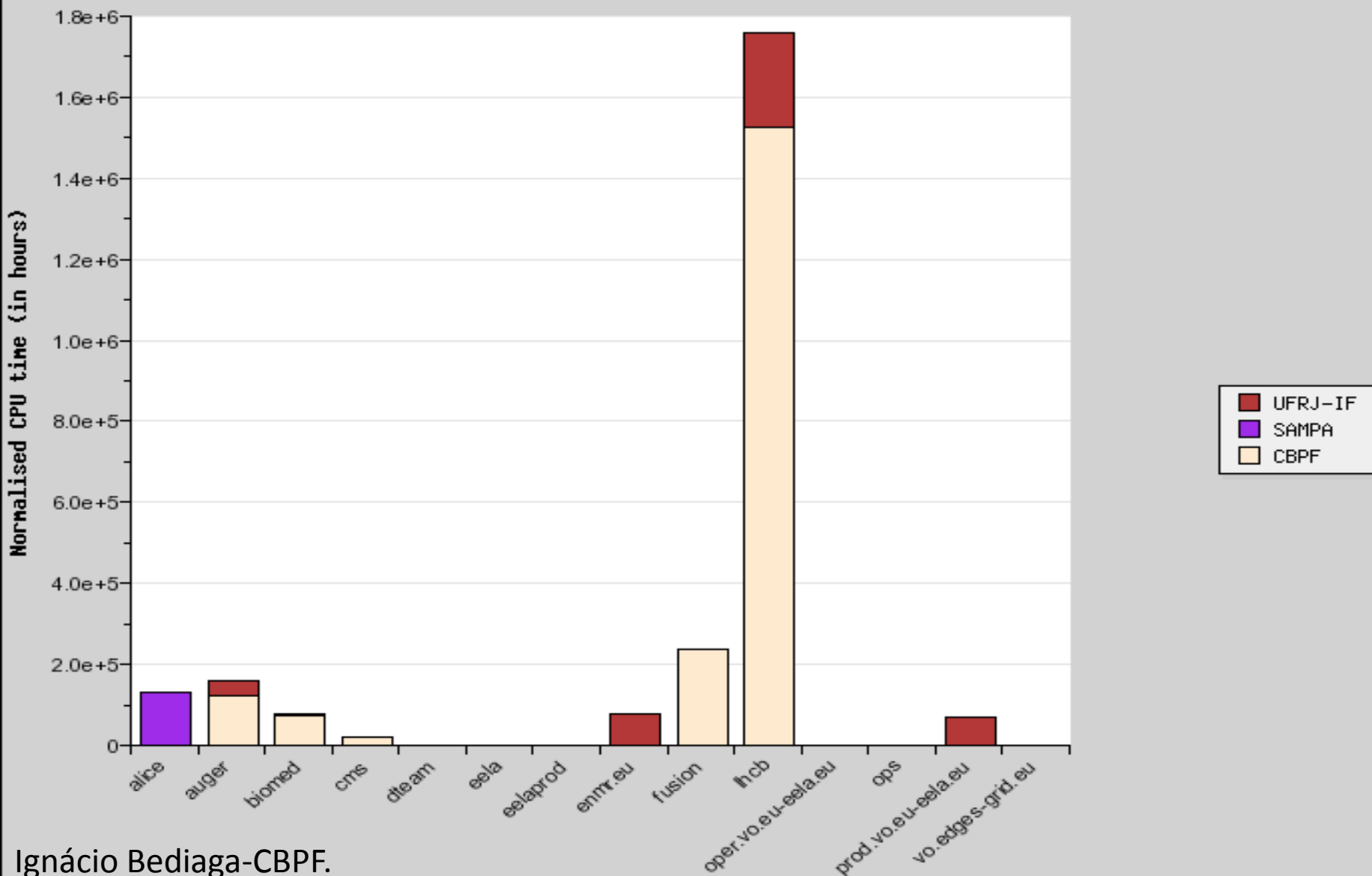
Normalised CPU time [units 1K.SI2K.Hours] by SITE and VO																
SITE	alice	auger	biomed	cms	dteam	eela	eelaprod	enmr.eu	fusion	lhcb	oper.vo.eu-eela.eu	ops	prod.vo.eu-eela.eu	vo.edges-grid.eu	Total	%
CBPF	0	123,221	75,497	21,620	67	0	0	0	237,921	1,524,242	0	1,100	0	0	1,983,668	78.18%
SAMPA	132,904	0	1,615	0	2	0	0	0	0	0	0	142	0	0	134,663	5.31%
UFRJ-IF	0	37,902	0	0	14	143	551	76,804	0	232,916	0	291	70,505	0	419,126	16.52%
Total	132,904	161,123	77,112	21,620	83	143	551	76,804	237,921	1,757,158	0	1,533	70,505	0	2,537,457	
Percentage	5.24%	6.35%	3.04%	0.85%	0.00%	0.01%	0.02%	3.03%	9.38%	69.25%	0.00%	0.06%	2.78%	0.00%		

[Click here for a csv dump of this table](#)

[Click here for a EXTENDED csv dump](#)

[go to top](#) ▲

# **Brazil Normalised CPU time (kSI2K) by SITE and VO** **ALL VOs. November 2008 - January 2011**



Ignácio Bediaga-CBPF.

# T2-HEPGRID-Brasil-UERJ

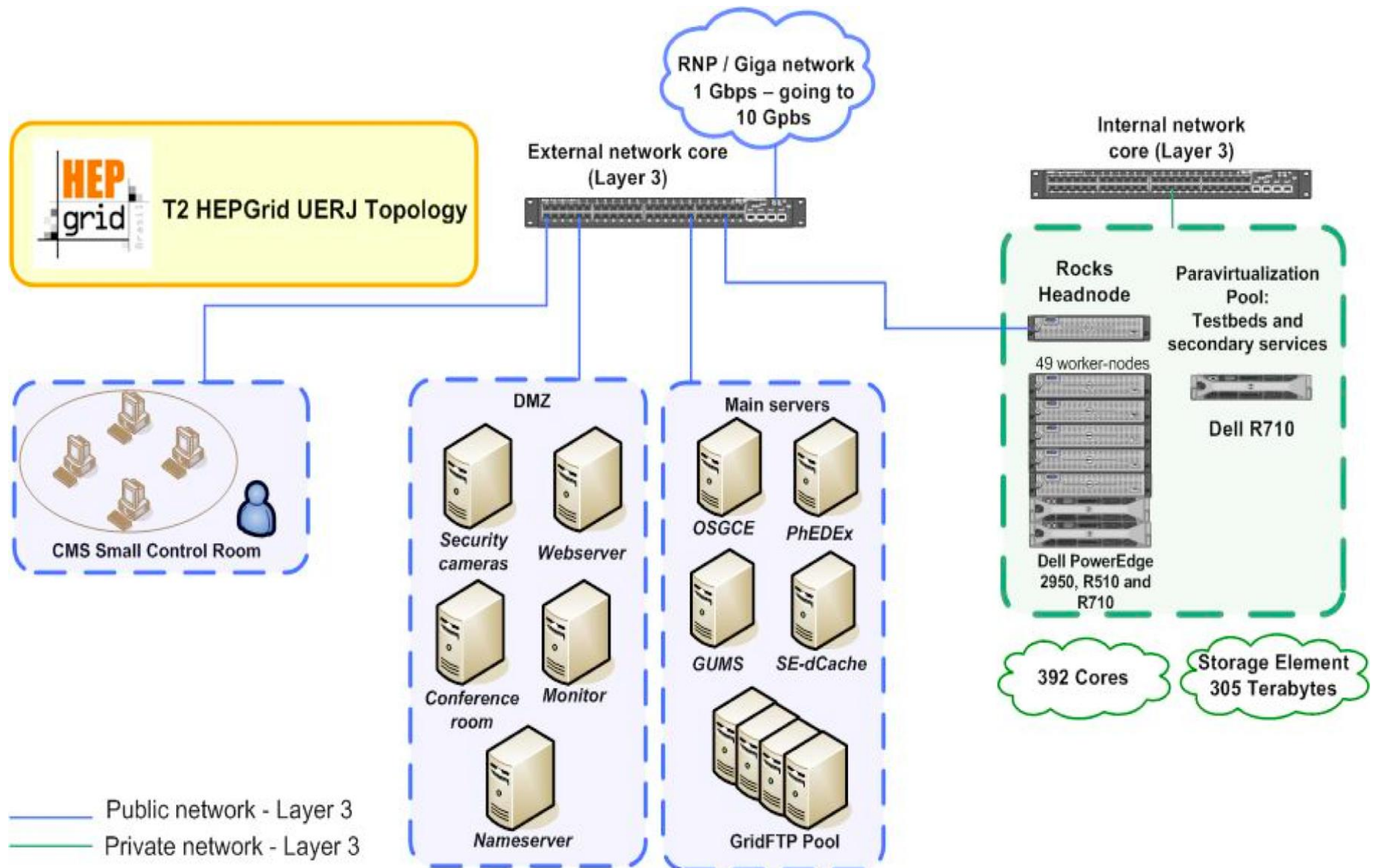
Last Version Machines on Raks



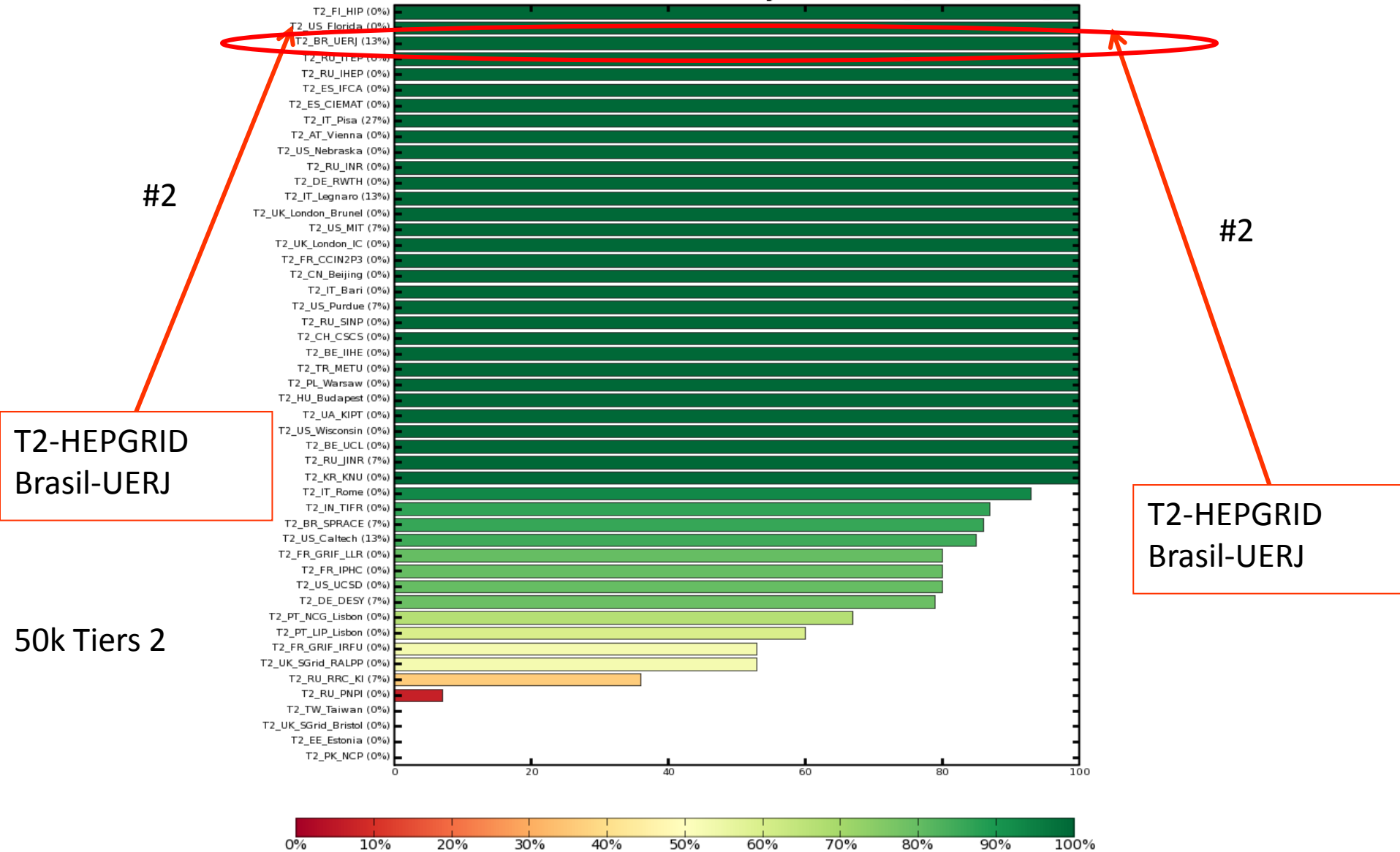
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# TOPOLOGY OF T2-HEPGRID-Brasil-UERJ

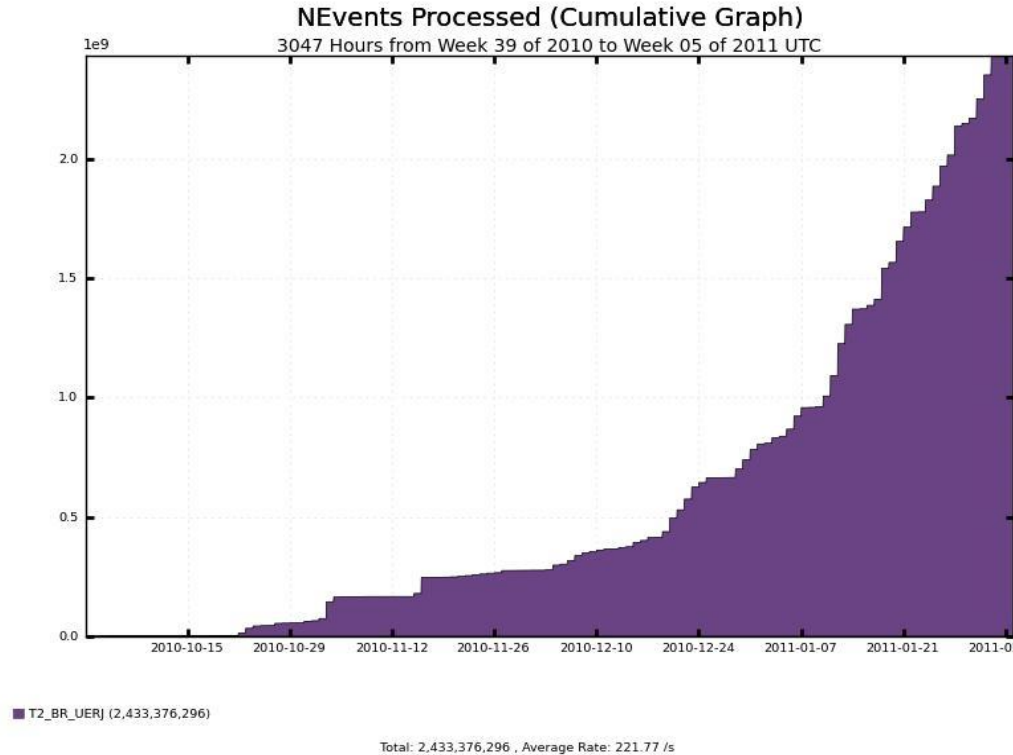


## T2 Readiness Rank last 15 days (+SD %) [2011-02-02]

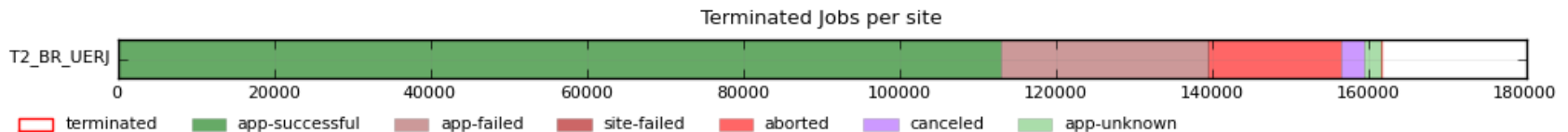
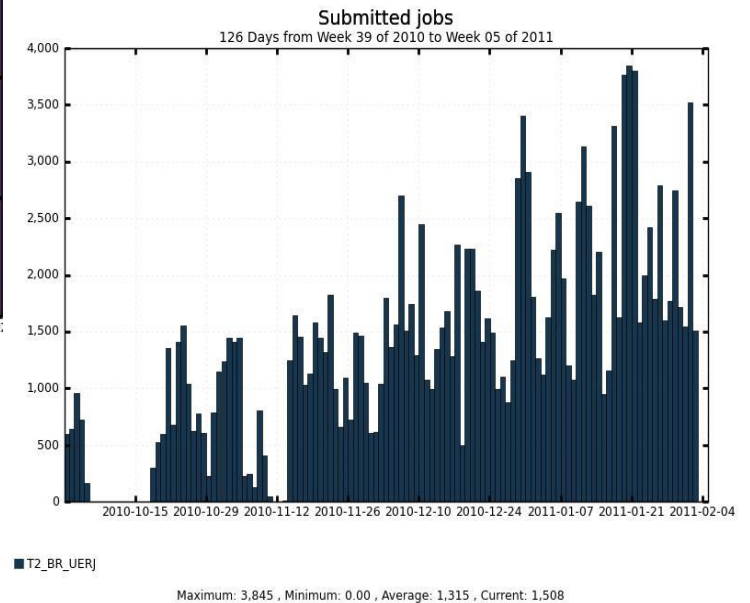


This rank is composed based in several checks and parameters related to a cluster facility to ensure functionality.

# Total amount of CMS analysis events processed at T2\_BR\_UERJ between 15.10.2010 and 04.02.2011.



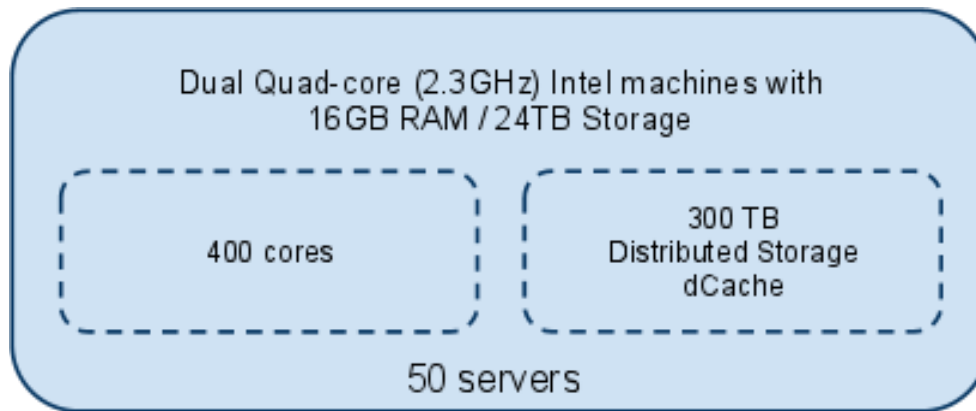
Total of events: 2.433.376.296  
Average: 221.77 events / sec





# Current Infrastructure

- **Cluster**
  - Three racks with fifty workernodes and four ethernet layer 3 switches ;
  - **Additional servers dedicated to provide Grid Services;**
    - **Data transfers (PhEDEx + GridFTP)**
    - **Job submission (computer element + Condor)**
    - **Distributed storage (dCache 1.9.5)**
    - **General services: webserver(optional), nameserver (optional), local account server(optional), monitor server (optional);**



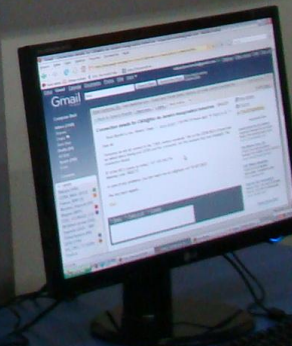
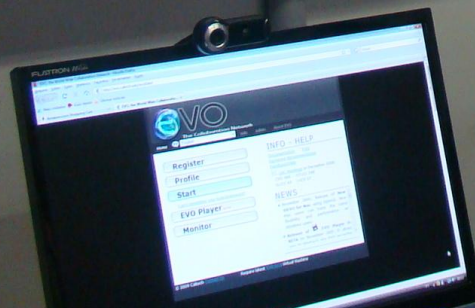
- CMS small control room and analysis terminals
  - Two big screens (47");
  - Four workstations dedicated to do shifts in CMS collaboration;
  - Six machines exclusive for analysis and job submission;

SMALL CONTROLL ROOM – UER/CMS





## SMALL CONTROL ROOM – UERJ/CMS



# We Learn a lot

What we have to take into account in a country like Brazil?

1. Start the project by an initiative of a group.
1. HEPGRID is an International business than: Permanent discussion with all colleagues. Hear the Positive and Negative opinions.
3. Define Schedule and Priorities.
4. Bandwidth. Less than 1 Gbps, forget ! 10 Gbps is good...more is VG.
5. Our choice was always Distributed Storage
5. As we started early to work on this technology, and had more friends in USA, our option was to be connected to the OSG. More than that: Our Group have been helped a lot by Tier2-USA which are fantastic.
7. Never forget → Purpose: Physics



## GROUP UERJ

UERJ-Professors	UERJ-Students PhD. Program	UERJ-Students Master Program	UERJ Engineers
Alberto Santoro	Sheila Mara	Diego Figueiredo	Eduardo Revoredo
Andre Sznajder	Eliza Melo	Ana Thereza Rosa	José Afonso Sanches
Carley Martins	Walter Aldá	Juliana Boaretto	Diego Gomes
Helio Nogima	Jordan Martins	Analú Custódio	Alan Malta
Luiz Mundim	Luana S. Jorge		Samir Cury
Vitor Oguri			<b>CEFET</b>
Wanda Prado			Alexandre Zachi - Jesse Werner - Lourival Moreira
Wagner Carvalho			<b>UFRGS COMPUTING:</b>
Sandro Fonseca			Marko Petek - Diego Gomes - Alan Malta
<b>CBPF</b>			
PROFESSORS - M.E.Pol - G. Alves - M. Souza - Dilson de Jesus			

# CMS Brasil

- **Composition**

- 7 Institutions in 3 States
- 41 members
  - 18 professors and Researchers
  - 23 Students & Technicians

- **Physics Analysis**

- Diffraction
- Exotica
- Higgs
- Eletroweak
- Heavy Ions

- **Computing Infra-structure**

- Tier2 UERJ – Rio de Janeiro
- Tier2 SPRACE – S. Paulo
- Tier2 CBPF – Rio de Janeiro
- Small Control Room (CMS)

# III- Conclusion - What Can We do?

I am very happy that finally we will have a Tier 1 for HEP in L.A.

The success of our major scientific programs, and the **health of our global collaborations, depend on physicists from *all world regions* being full partners** in the scientific enterprise. This means that they must have access to affordable networks of **sufficient bandwidth**, with an overall scale of performance that advances rapidly over time to meet the growing needs.

Harvey Newman, Paris ICFA General Meeting Feb.2004, SCIC Report

Thank you for invite me to this Workshop

México Tier 1





## Extra Slides

1. ACP1 - Born from a need of Fix Target Experiment  
(parallelism, little Unix) -1986
2. ACP2, ACPMAPS – (1 ACP2=10 ACP1, Lattice Calculations)  
(1990-1994)
3. Client/Server - FARM-IBM – (Collider: D0, Monte Carlo  
Production, too advanced -1997
4. CPS - 1994
5. Heterogeneous Network (VMS+NOVELL+UNIX+WINDOWS) (1986)
6. CHEP95 – Use Videoconference – Internacional (1995)

**Porque?**

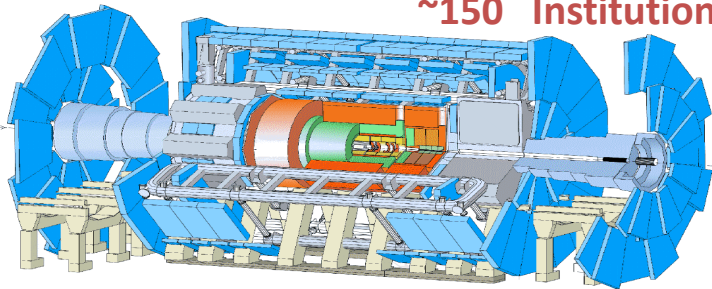
## Four Experiments

LHC

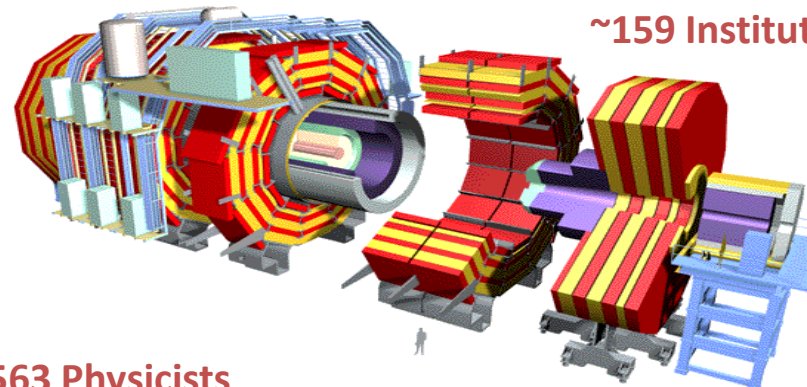
Petabyte to Exabyte

Higgs and New Particles; Quark-Gluon Plasma; CP Violation; Diffractive Production

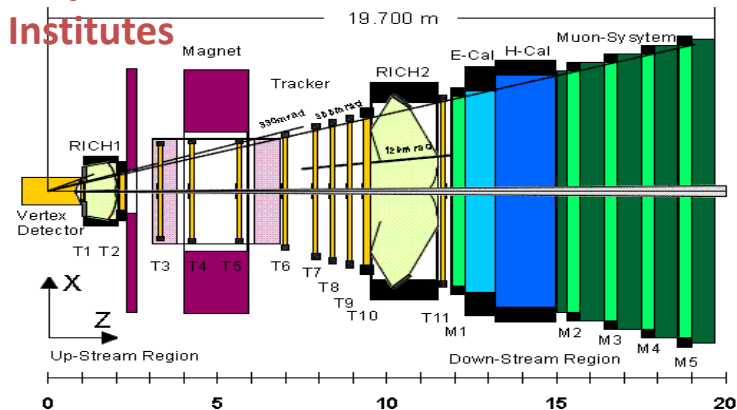
ATLAS, ~2000 Scientists  
~150 Institutions



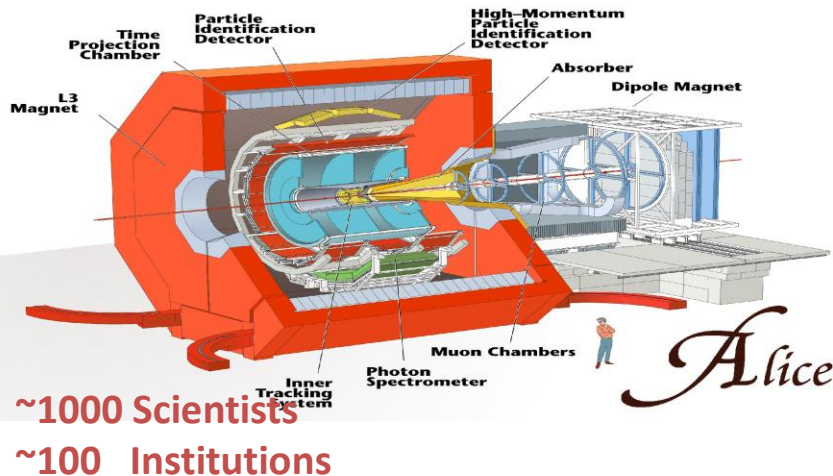
CMS, ~2000 Scientists  
~159 Institutions



~563 Physicists  
~50 Institutes



LHCb



*ALice*

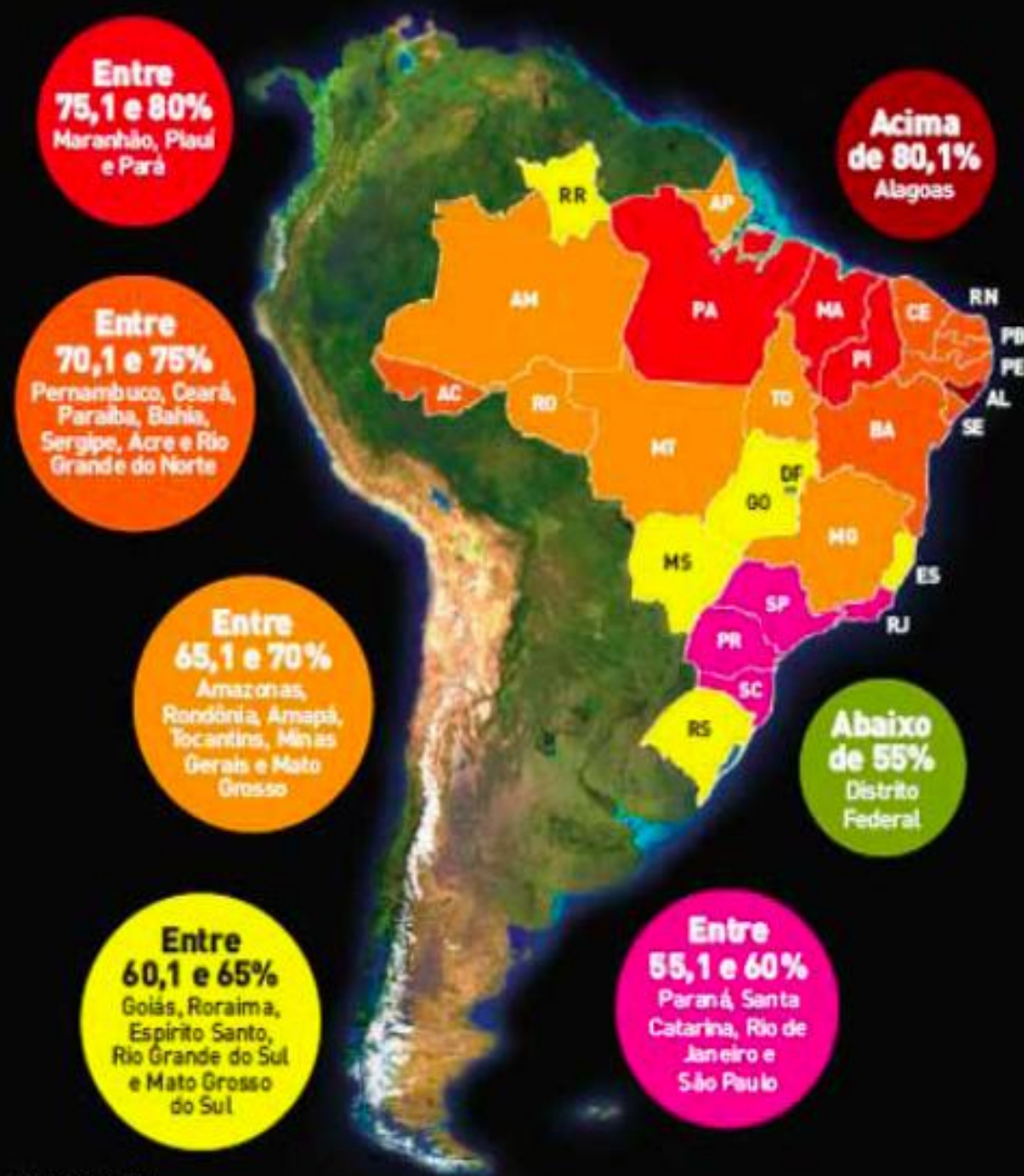
~1000 Scientists  
~100 Institutions  
~5 Petabytes/Year/Experiment (1 PB =  $10^{15}$  Bytes)

(~2010) Exabyte (1 EB =  $10^{18}$  Bytes) Total for the LHC Experiments

LHC Bandwidth Requirements in Mbps will be very important → Networks!

# O MAPA DA EXCLUSÃO DIGITAL

Confira quantas pessoas não acessam a web por estado



## ACESSO APENAS POR LAN HOUSES

Em %

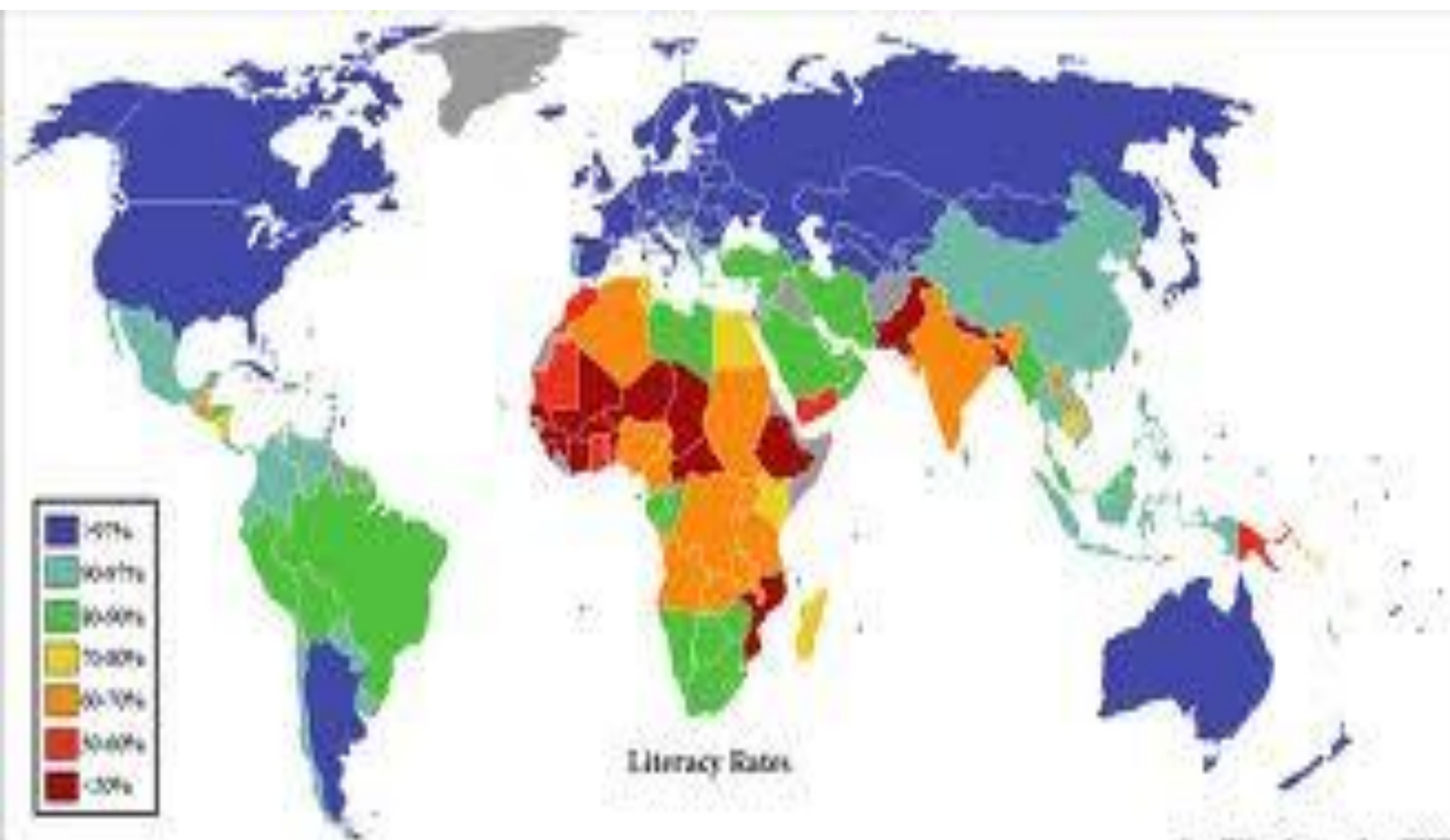


## CONCENTRAÇÃO NAS REGIÕES METROPOLITANAS

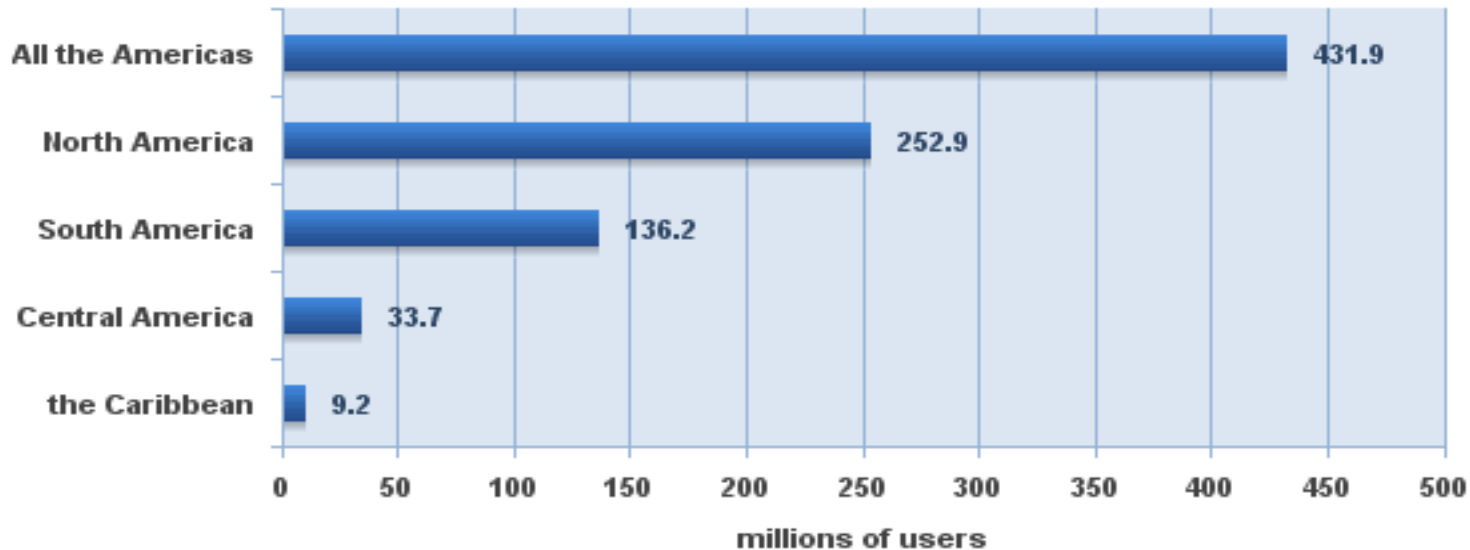
Em %



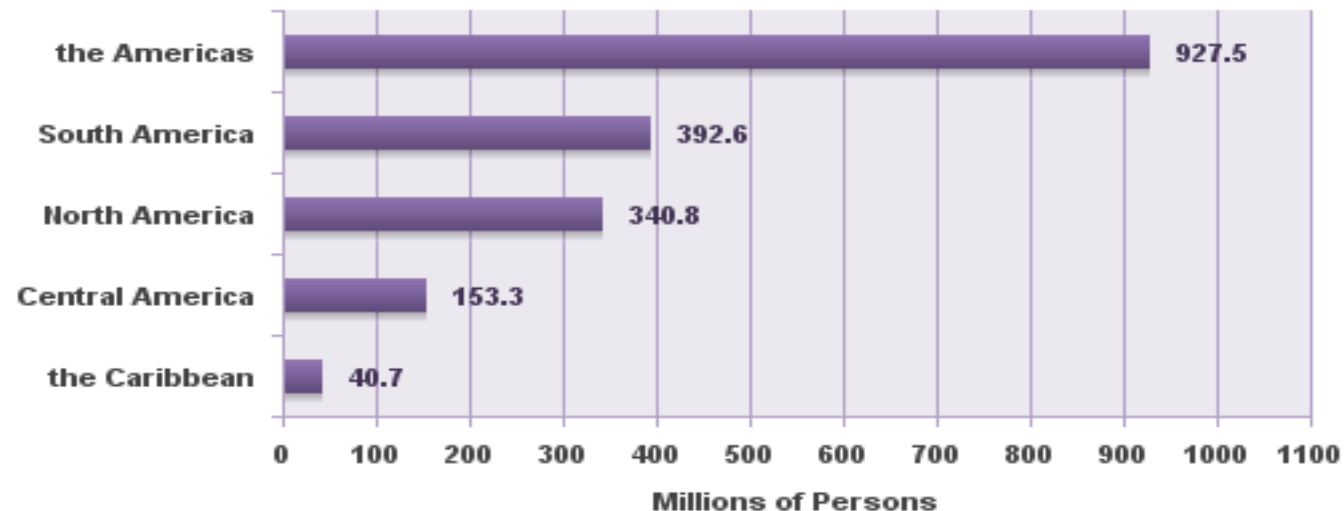




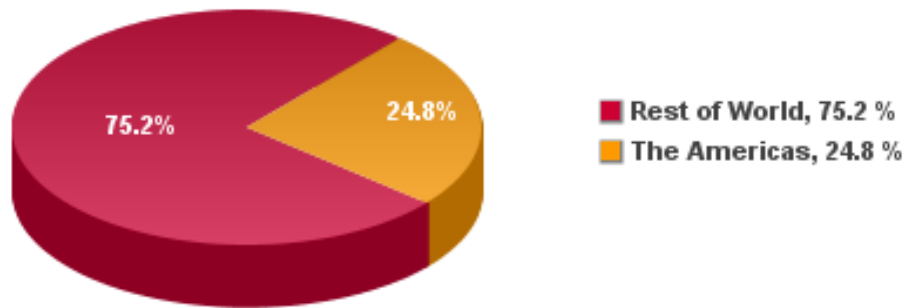
## Internet Users in the Americas Geographical Distribution - 2009



## Population in the Americas 2009 mid-year Average



## Internet Users in the Americas



Source: Internet World Stats - [www.internetworldstats.com](http://www.internetworldstats.com)  
446,483,050 estimated Internet users in the Americas on Dec. 2009  
Copyright © 2010, Miniwatts Marketing Group

## Internet Penetration Rate in the Americas 2009 Year-end

