Big Data &
Remote Scientific Collaboration Projects

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LARC – USP

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University of São Paulo

- Created in 1934
- **11** campi (4 – city of São Paulo).
- **89** University Divisions.
- **92.064** students (undergrad, grad and extension).
- **5.860** professors.
- **16.837** administrative staff.
- **249** undergraduation programs.
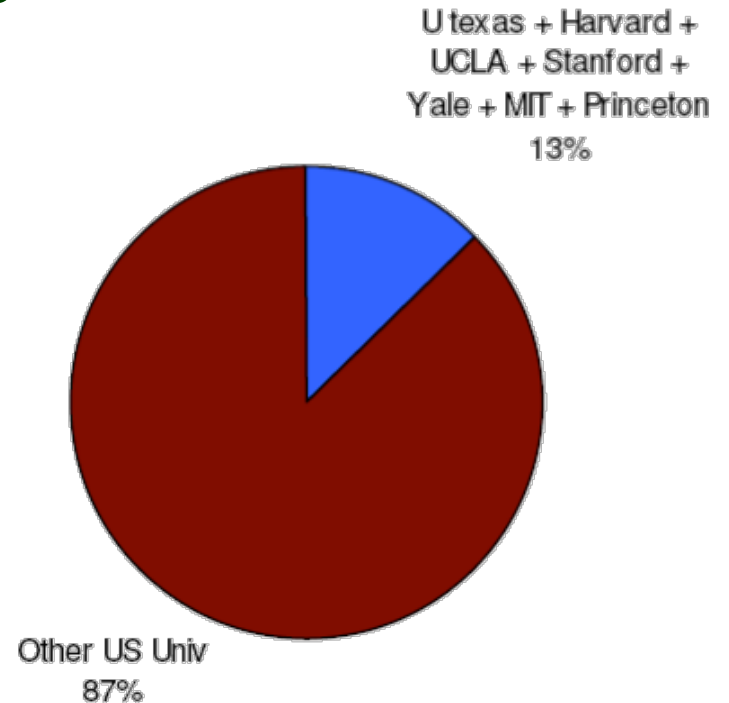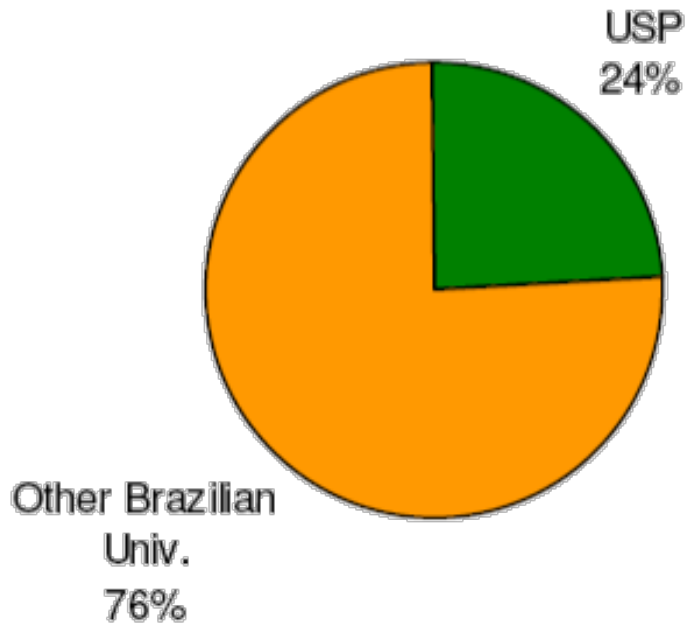- **239** graduation Programs

Public University, founded in 1934

USP: Importance in Brazil

ISI indexed papers: 31548

MIT : 35103

Yale: 35663

USP
24%

Other Brazilian
Univ.
76%

U texas + Harvard +
UCLA + Stanford +
Yale + MIT + Princeton
13%

Other US Univ
87%

LARC-USP

LARC-USP

- Computer Networks and Architecture Lab
  - **Created in 1993.**
  - **8 professors**
  - **50** collaborators, distributed among Doctorate, Master and Undergrad **students and full-time researchers**

- Main fields of interest
  - Security
  - High-Definition Media & Visualization
  - Wireless and sensor networks
  - Advanced Internet & Applications
  - SDN (Software Defined Network)
  - High-Performance Hardware For Networking
  - Cloud Computing

Main Partnerships

- **RNP** (National Network for Research and Education)
- **ANSP** (Academic Network of São Paulo State)
- **FIU** (OSCD – Big Data + Cloud Computing)
- **I2Cat** and **Bristol University**

- **Ericsson Research** Sweden, Canada, Finland
- Center for Innovation - **Ericsson Brazil**
- **IBM Research** – T.J. Watson
- **Intel Research**
- **Bradesco Bank** & **Scopus Tecnologia**
- **Petrobras** (Brazilian Oil Company)
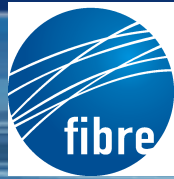
Scientific Remote Collaboration Projects

- Characteristics
  - **Collaborative Projects** involving multiple Partners
  - Usually **infrastructure + Use Cases / Demos**

- 3 Main Areas
  - New Network Architectures
  - High-Definition Media & Visualization
  - Cloud Computing & Big Data
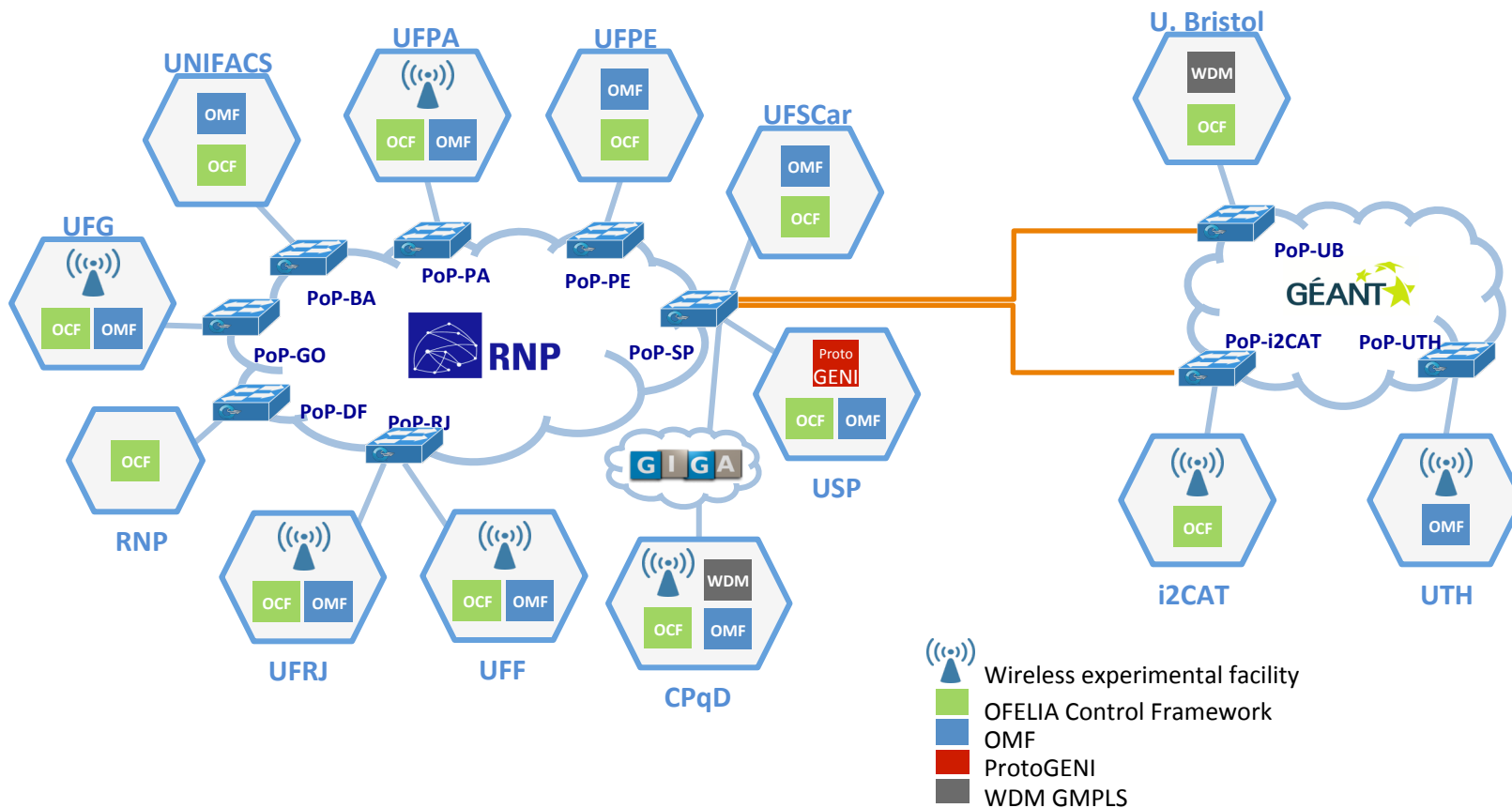
New Network Architectures

FIBRE Project
Future Internet - BRazil - Europe

- **Shared Infrastructure** for **research on Future Internet**
  - **Similar to GENI Project in US**

- Brasil: **10 Islands** interconnected by means of RNP (Brazilian NREN)
  - **OpenFlow Switches**, **NetFPGA servers**, computation **servers**, **wireless nodes (All Programmable)**
  - **USP** Island also contains an **Emulab/ProtoGENI cluster** (Network Emulation)

- Europe: Univ.Bristol, i2Cat (Spain), UTH (Greece)

- Main Coordination: Prof. Antonio Abelem (UFPA University)

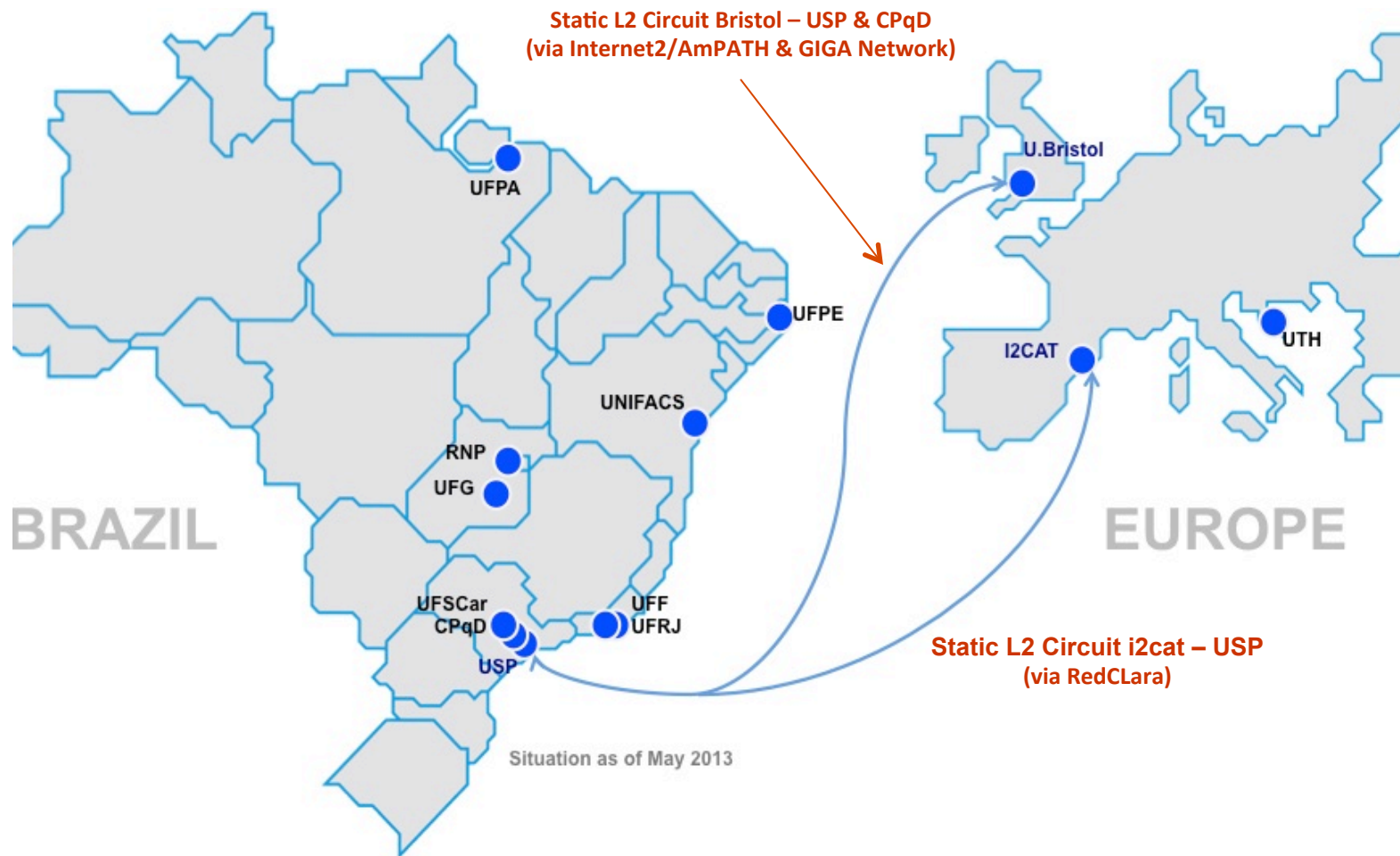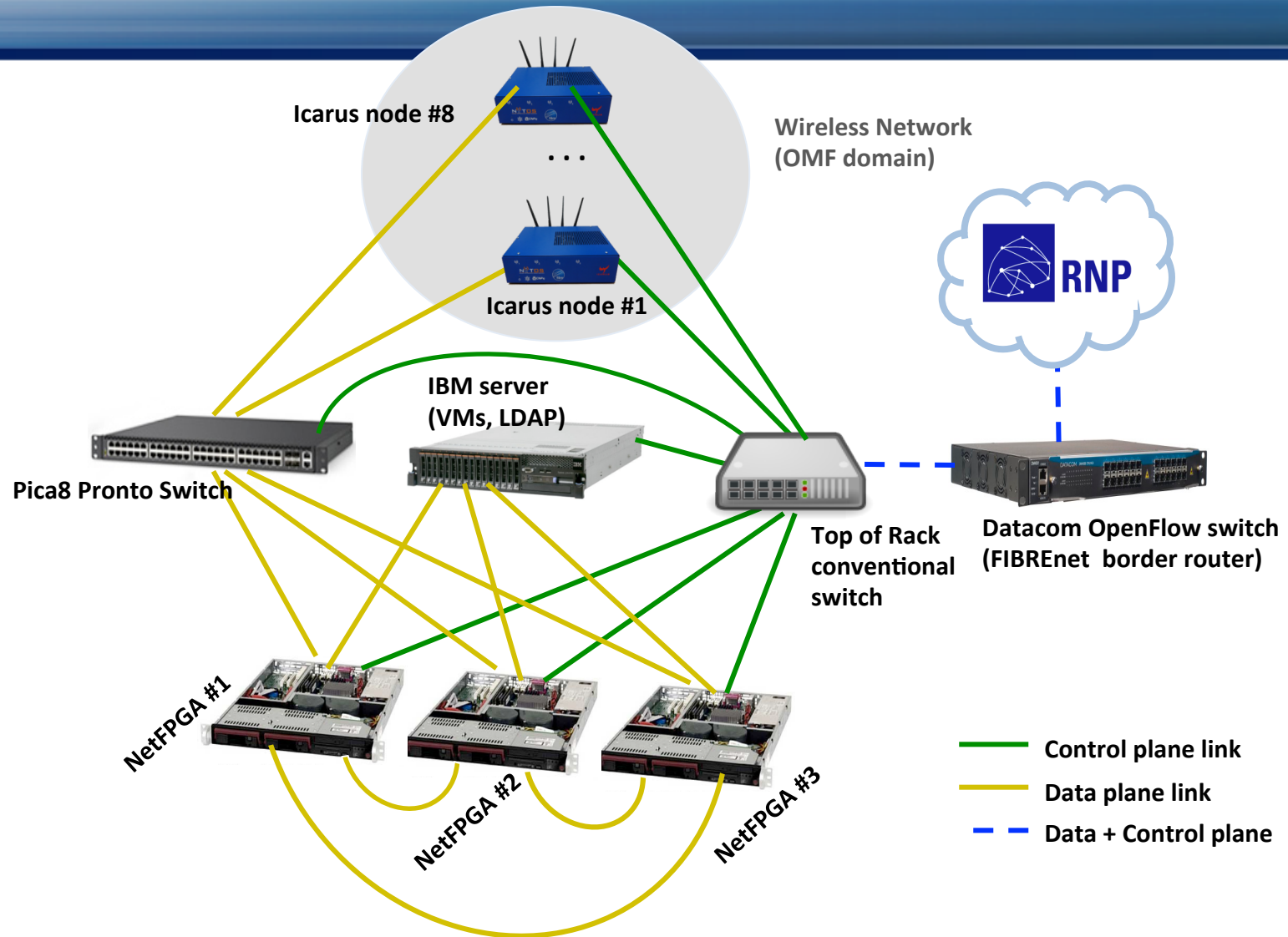- USP Island Coordination: **Profa. Tereza Cristina M. B. Carvalho**

FIBRE Members

Source (adapted): Michael Stanton (RNP)

Static L2 Circuit Bristol – USP & CPqD
(via Internet2/AmPATH & GIGA Network)

Static L2 Circuit i2cat – USP
(via RedCLara)

Situation as of May 2013

Fibre Island

Icarus node #8

Wireless Network
(OMF domain)

Icarus node #1

IBM server
(VMs, LDAP)

Pica8 Pronto Switch

Top of Rack
conventional
switch

Datacom OpenFlow switch
(FIBREnet border router)

NetFPGA #1

NetFPGA #2

NetFPGA #3

Control plane link

Data plane link

Data + Control plane

Emulab/ProtoGENI @LARC

- Emulab
  - **Cluster** for **network emulation**
  - Created by Univ. Utah

- Emulab @LARC (2007-)
  - **24 nodes, 5 switches**
  - **Migrated to ProtoGENI (2012)**
  - **Federated** with US ProtoGENI project
  - **Static & Dinamic Vlans for demos**


emulab

protogeni

Demos for Advanced Internet

- Goals
  - Demonstrate the viability of Advanced Internet features for different types of research
    - L2 Dynamic Circuits
    - Software-Defined Networking (Openflow)
 - Integration with International Community

Demo 1: "Slice Around the World" - Out/2012

- 1st **Experiment** involving **experimental Future Internet testbeds** among 3 continents
  - Dynamic Resource Sharing among BR and USA testbeds
  - Interconnected by dynamic circuits (Brazil SE-CIPO & I2 ION)
  - **Non-IP traffic** from **Japain** to **Brasil**, **"routed"** at **Utah**
 - **15th GEC -** GENI Engineering Conference **(10/2012)**
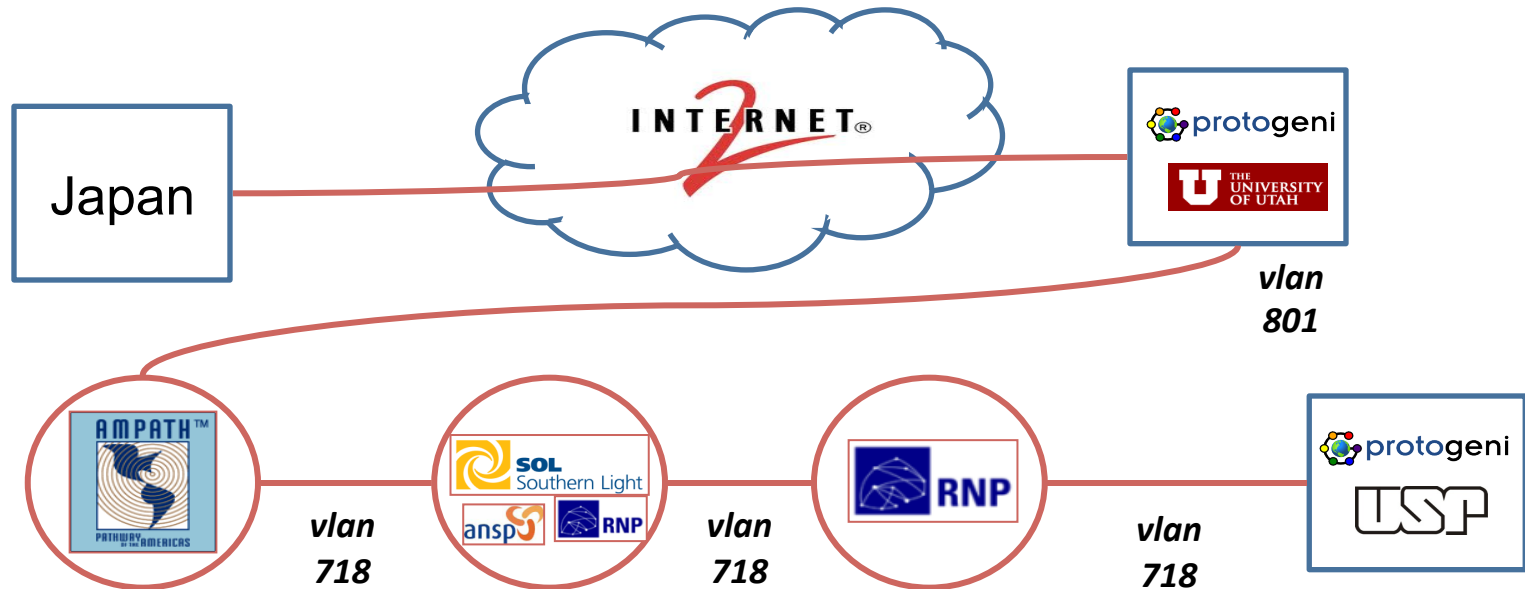
Demo 2: Live Song   - Nov/2012

- **Demo for FIBRE Evaluationg Comitee**
- 1ˢᵗ FIBRE Workshop – Salvador, Brazil
- **Singing Master Class**
  - **Professors/students** at **Barcelona, Spain** & **São Paulo, Brazil**
    - **Compressed Video, Uncompressed Audio**
  - Use of a L2 circuit (w/ Openflow) using project FIBRE's testbeds
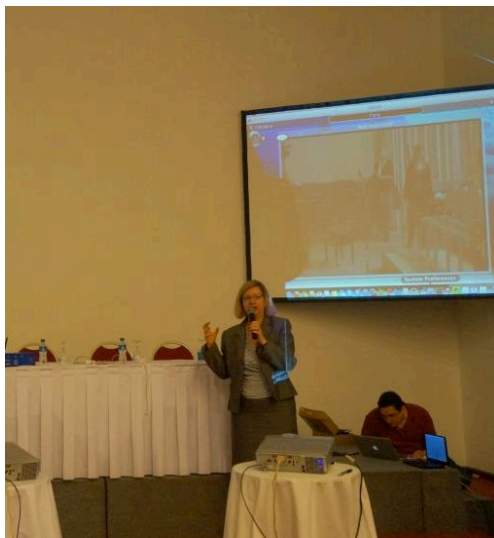
Demo 3: TransGeo - Mar/2013

- **Experiment** involving an application distributed among multiple **experimental testbeds**
  - L2 overlay network involving several countries
  - **TransCloud:** Geoprocessing application executed on several **"Clouds"** (experimental testbeds) on top of GENI
 - **16th GEC -** GENI Engineering Conference **(03/2013)**
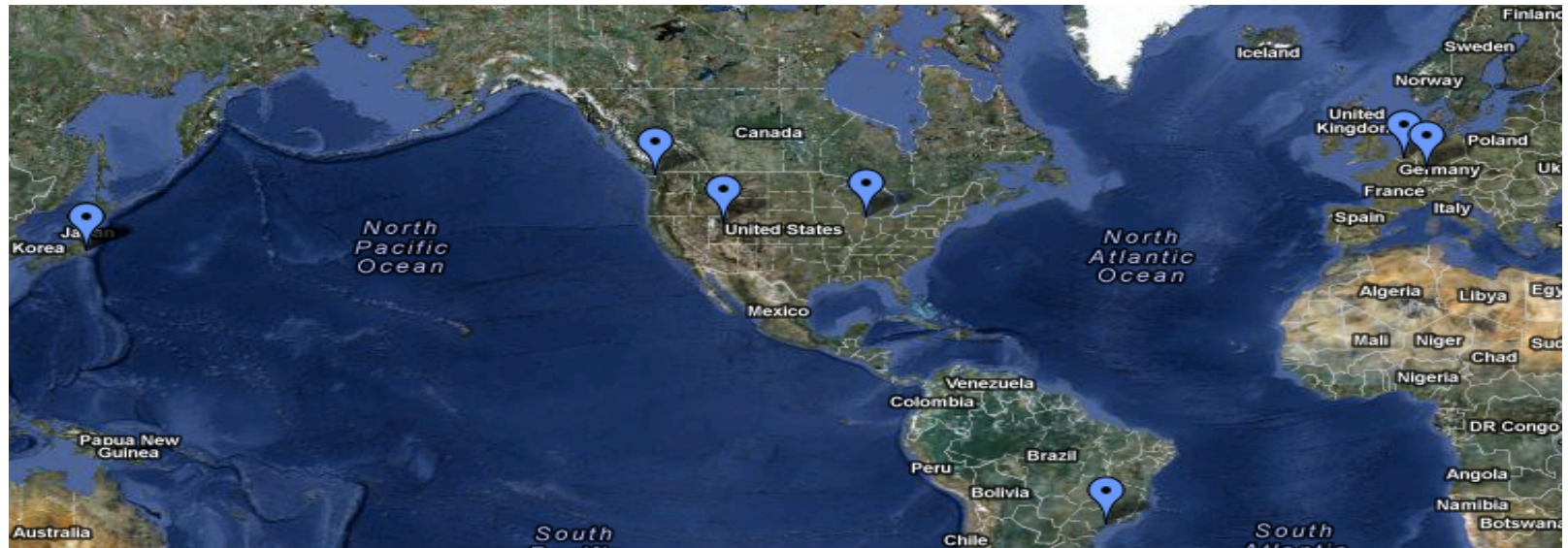
TransGEO

Alison Blackduck, Aki Nakao, Jim-Hao Chen, Joe Mambretti, Andy Bavier, Paul Muller, Dennis Schwerdel, Andreas Teuchert, Rob Ricci, Chris Matthews, Yvonne Coady, Yanyan Zhuang, Stephen Tredger, Sean McGeer, Justin Thompson, Yvan Savard, Nicki Watts, Niky Riga, Gary Wong, Lee Stoller, Brecht Vermuelen, Maarten De Wispelaere, Piet Demeester, Wim Vandenberghe, Cees de Laat, Julio Ibarra, Chris Griffin, Jeronimo Bezerra, David Pokorney, Luis Lopez, Carlos Ribas, Michael Stanton, James Grace, Jason Liu, Tereza Carvalho, Marcos Schwarz, Fernando Redigolo, Rick McGeer

TransCloud: Based on iGENI, InstaGENI, VNode
- Transcontinental Federation of Cloud Systems
- Slice-Based Federation Architecture for sign on and trans-cluster slice management
- SFA cluster manager at each site
  - OpenStack enhanced to support SFA under development
- Private 10 Gb/s transcontinental network linking sites
  - Thanks to GLIF, NLR, NetherLight, CAVEWave, Starlight, DFN, UEN, JGN, Canarie, I2, BCNet, Geant, RNP, I2...
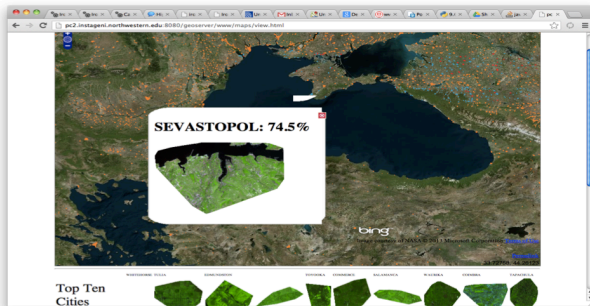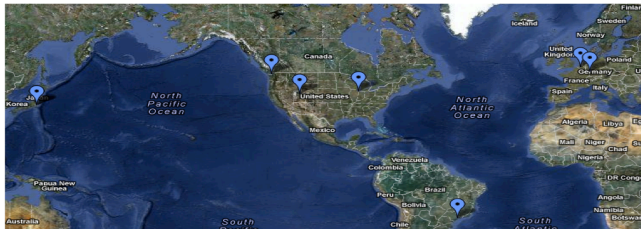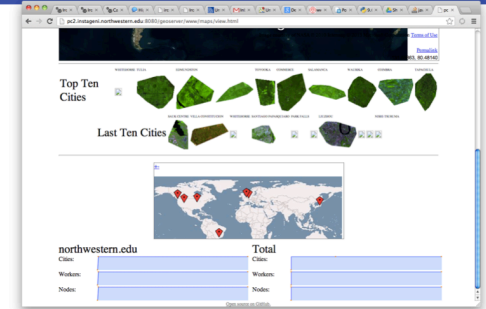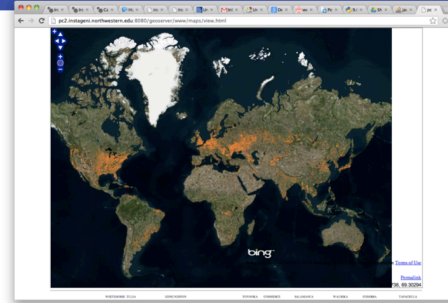
Example of working in the TransCloud
[1] Build trans-continental applications spanning clouds:
- Distributed query application based on ironMQ
- Store Landsat data on distributed Swift
- Query data using postgis over distributed Swift Clusters
[2] Perform distributed query on TransCloud, which currently spans the following sites:
- UVic (InstaGENI)
- Utah(InstaGENI)
- University of Ghent
- University of Tokyo (VNode)
- Northwestern University (InstaGENI)

Packet-caching from Xia and VNode

SEVASTOPOL: 74.5%

Top Ten Cities

Science DMZ

What is a Science DMZ ?

- **Specialized Network Architecture** for **high-performance scientific computation**, with **differentiated policies and configuration** in comparison to production network.

- Optimized machines for content **transfer and monitoring.**

- **Priviledged Connectivity**

- Concept created by DoE ESNet

(SD)² - Software-Defined Science DMZ

- Coordination:
  - **Profa. Tereza Cristina Melo de Brito Carvalho**
  - **Fernando Frota Redigolo**

- Sponsorship
  - **RNP (Brazilian NREN)**

- Partnership:
  - Electronic Computer Center/USP
  - INPE
  - National Observatory
  - Federal Institute of Pernambuco
  - Federal University of Pernambuco
  - Federal University of Rio de Janeiro
  - RNP

(SD)² - Software-Defined Science DMZ

- Main goals:
  - Develop a **Science DMZ Prototype with Openflow capability** for Brazilian universities.
    - '**Low-cost' Science DMZ Kits** (1G & 10G) that could be easily found in BR market and 'easily' deployed (similar to the GENI rack concept)
  - **Specify and Implement** the Sc.DMZ Prototype in 7 Institutions
  - Architecture **Evaluation** under **Use Case Scenarios**

(SD)² – Use Cases

Institutions	Application	Data set	Notes
UFRJ	Images and videos Neurology	**200GB/ day**	They can not perform the research because they have connection and bandwidth problems.
UFPE	BD Vegetal Genetics	**18TB/day**	Wget – **3 to 4 weeks** scp - **4 to 6 weeks**
INPE	Meteorological Data	**240 MB/ day**	**24 hours** to transfer
USP	LHC Alice Experiment	-	They use practically only local simulated data, as the connectivity is deemed insufficient for real-time data transfer

Two other institutions (National Observatory and IFPE) will receive their kit later this month

(SD)² - Equipment Selection

- **Switch** Requirements (10G)
  - **60+ MB buffer**
  - Hybrid-mode **Openflow**
  - Provider Features (**Q-in-Q** mandatory, MPLS desirable)
  - **4 x 10G ports**, 20 x 1G ports

- Selected Equipment
  - **Brocade CES 2024C-4X (192 MB buffer)**

(SD)² - Equipment Selection

- **DTN**
  - 64 GB RAM
  - **10** x 1TB enterprise **SATA** disks (7200 rpm, sustained throughput 170+MB/s & **1** x 120 GB **SSD** (for **caching**)
  - **RAID** Controller with **SSD cache support**
  - **10G Network Card** with **RDMA** support

(SD)² - Equipment Selection

- **DTN -** Selected Equipment
  - **Custom-made server** with Intel board and RAID controller

  - **Mellanox NIC**
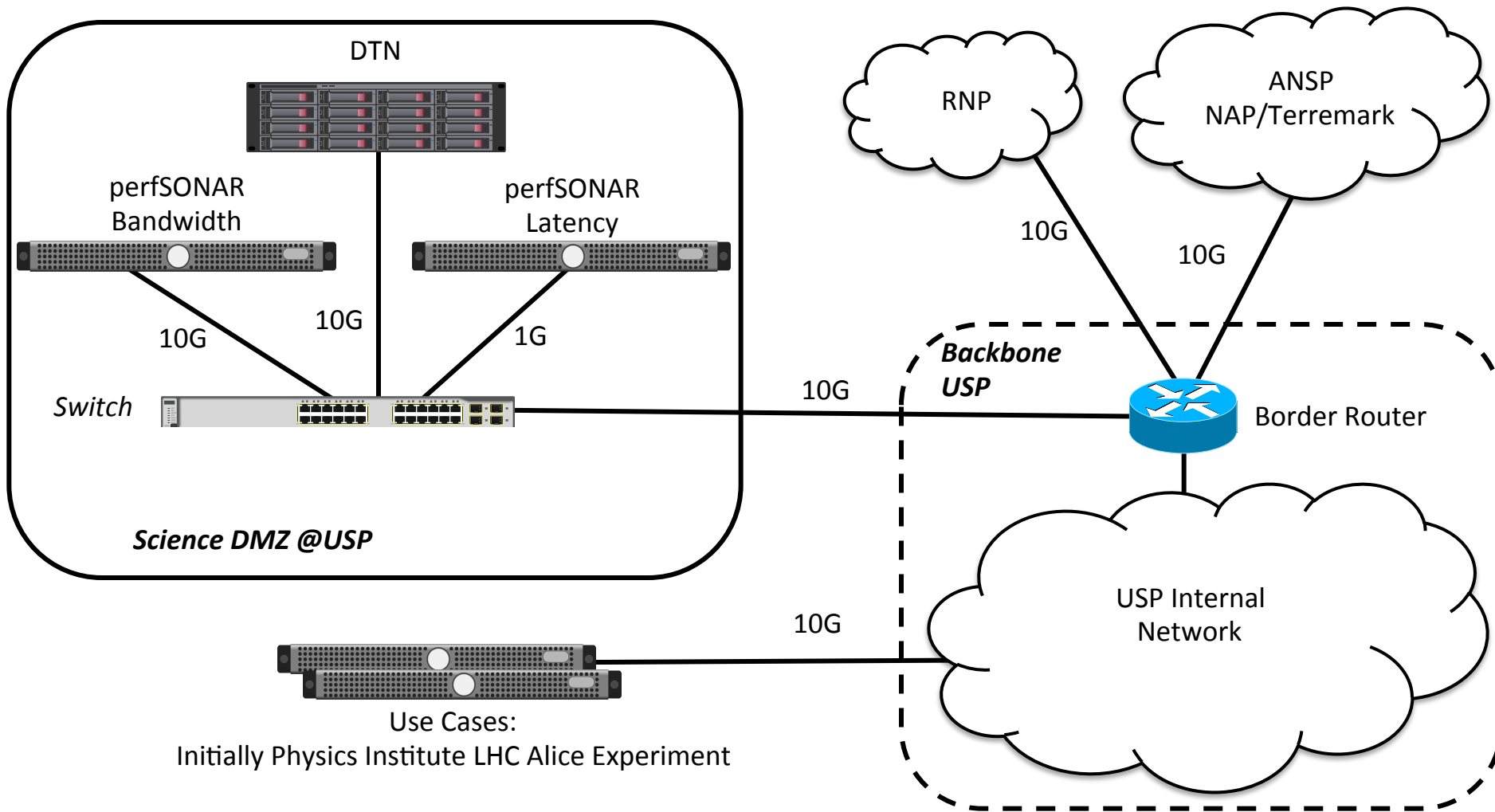   - **RMDA**
    - **Openflow**

(SD)² - Equipment Selecion

- 10G links
  - Using **Direct-Attach Copper** cable instead of Fiber
  - **Less than half** the cost
  - < 10m length

Science DMZ
USP – Ohio State University

Building a digital bridge for research collaboration between Ohio State University and São Paulo Campuses

- PIs:
    - **Prof. Marcos Simplício**
    - **Profa. Tereza Cristina Melo de Brito Carvalho**
    - **Márcio Faerman (OSU)**

- Sponsorship (Brazil)
    - **Joint Call FAPESP (State of São Paulo Sponsoring Agency) – Ohio State University (OSU)**

- Partnership:
    - **ANSP (State of São Paulo REN)**
    - **Electronic Computer Center**/USP

Science DMZ
# USP – Ohio State University

- Main goals:
  - **Interconnecting** USP <-> OSU **Science DMZs**
  - **Investigate Interoperability and performance** issues involving **L2/L3 connections** with and without **SDN**
  - Use this connected infrastructure for a **collaborative research between the 2 universities**.

Ohio State University Supercomputing Center

LARC-EPUSP Optiportal

Science DMZ – USP & OSU

- Areas for Collaboration
  - Biology
  - Climate
  - Astronomy
  - High Energy Physics
  - Medicine / Health
  - Agriculture
  - Arts & Digital Media
  - Genome
 - Remote Instrumentation
  - Visualization
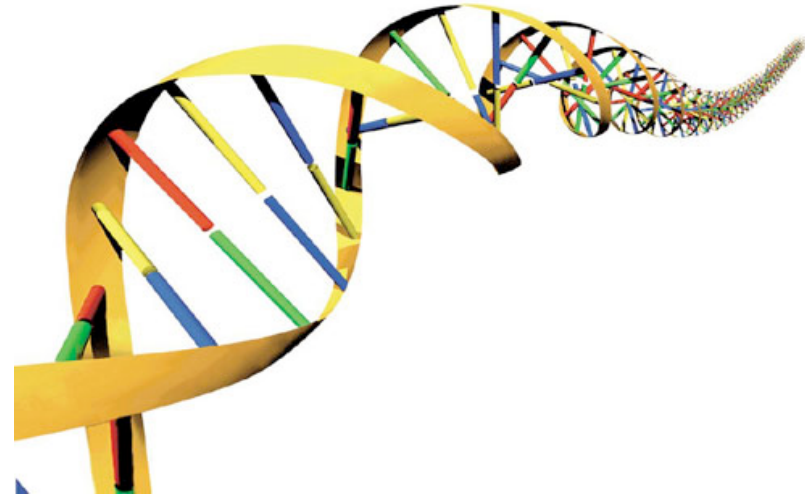
Visualization Projects

Visualization Portal - Optiportals

Environment for high-definition collaborative Visualization

- Based on Univ. Illinois SAGE middleware

- Multiple simultaneous content streamed through the network

- High-Def content (4K, 8K, *K)

- Multiple resolutions possible

- Interaction with portals from other institutions
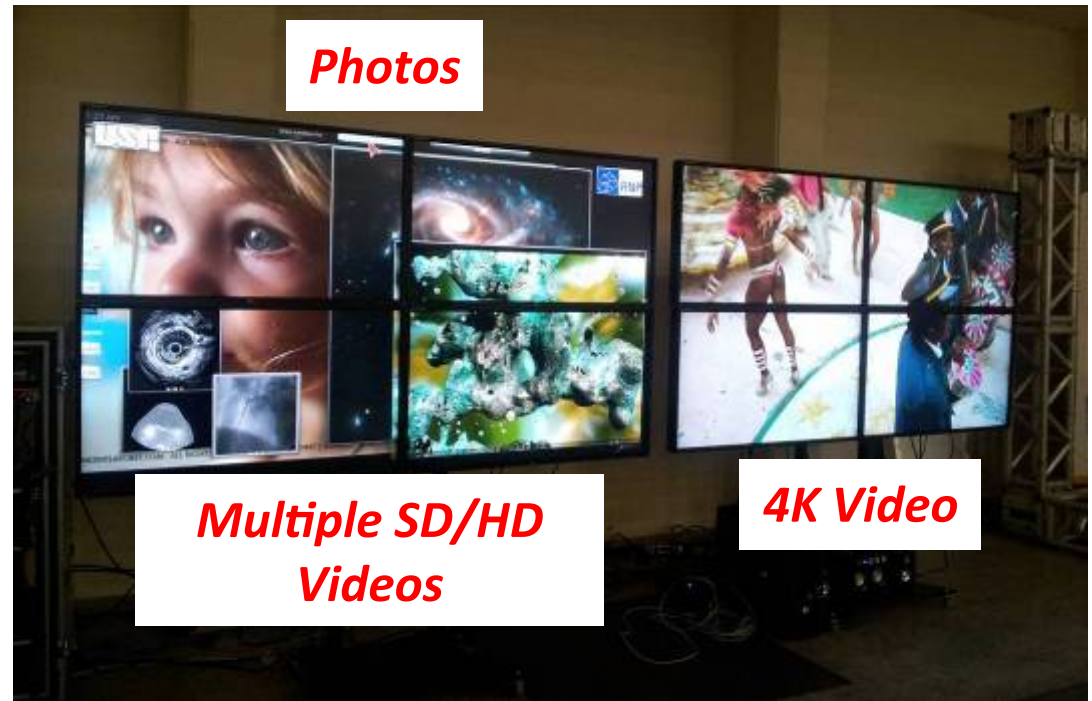
4x2 Portal - WRNP 2012

RNP OptiPortals Project

- Coordination:
  - **Profa. Tereza Cristina Melo de Brito Carvalho**
  - **Fernando Frota Redigolo**

- Sponsorship
  - **RNP (Brazilian NREN)**

- Partnership:
  - Fluminense Federal University
  - Bahiana Medical School
  - Santa Izabel Hospital
  - Federal University of Paraiba / LAVID
  - Mackenzie University
  - INPE
  - LASSU - USP

RNP OptiPortals Project

- Goals
  - **Collaborative work** among Brazilian Research Entities with **Tiled Displays**
  - **Disseminate** this technology to Brazilian R&D community
  - **Evaluate its** use for Scientific Applications (Use Case Analysis)

Cinegrid Brasil 2014

- **Cinegrid**
  - Community involving Digital Cinema, Arts and Scientific Visualization over networks

- **Cinegrid Brasil – Aug/2014**
  - Regional Meeting
  - Track on Scientific Visualization
  - Expected some 8K+World Cup Presentation

Cloud & Big Data

Cloud Computing

- **Several NDA-Covered Projects involving Security:**
  - Credential Management
  - Secure Virtual Networking
  - Security SLA
 - Security Visualization

GONZALEZ, N.M. et all. A quantitative analysis of current security concerns and solutions for cloud computing. Journal of Cloud Computing: Advances, Systems and Applications, v. 1, p. 11, 2012.

GONZALEZ, N. M. et all. A framework for authentication and authorization credentials in cloud computing. In: 12th IEEE International Conference on Trust, Security and Privacy in Computing and Communications, 2013, Melbourne. 12th IEEE International Conference on Trust, Security and Privacy in Computing and Communications. Melbourne: IEEE Computer Sociey, 2013.

Advanced Cloud Services for Telecom
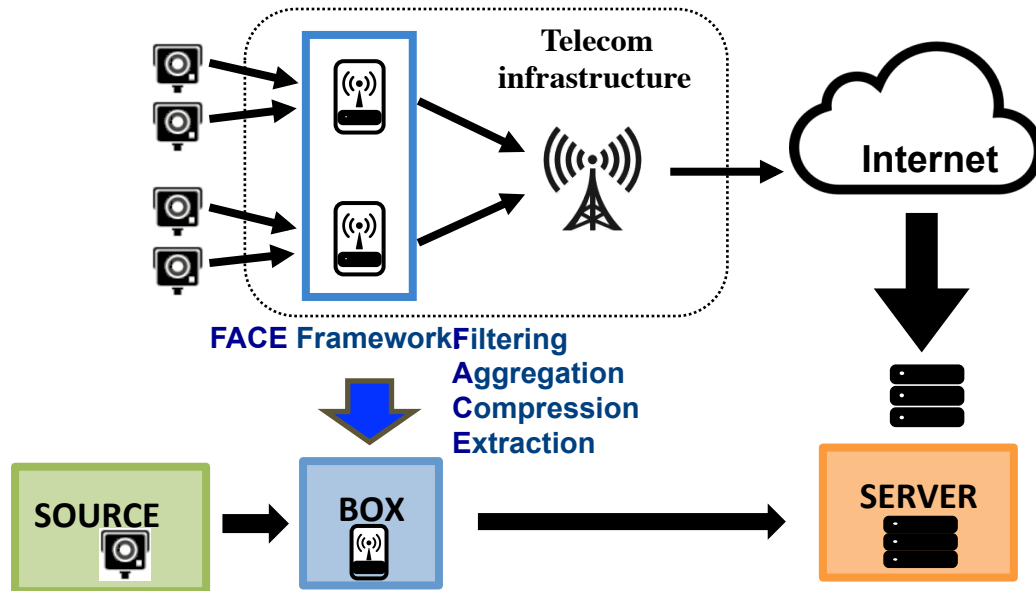
Goals:

- **Edge Processing** - Distributed Cloud Computing Framework for Telco Service offering

- **FACE Framework Prototype** – **Speed Radar** / Video Surveillance with Motion Detection

GONZALEZ, N.M et all. Cloud Distributed Processing Using Trade Wind. In: 2013 IEEE International Congress on Big Data (BigData Congress), 2013, Santa Clara. 2013 IEEE International Congress on Big Data, 2013. p. 437-438.

PEREIRA, R.F. et all. Distributed Processing from Large Scale Sensor Network Using Hadoop. In: 2013 IEEE International Congress on Big Data (BigData Congress), 2013, Santa Clara. 2013 IEEE International Congress on Big Data, 2013. p. 417-418.

Network Traffic Modelling

- **Model** a Company-owned **satellite network**
  - **Reverse-Engineering** the network **inner working**
  - Needs real **captured traffic** - Identify applications & traffic patterns
  - Analyze 'What-if' Scenarios
  - **1-2 TB** data (packet headers only) for a **1-week capture**
  - Starting using **Big-Data-related techniques** to cope w/ it

Thank You!

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