Big Data & Remote Scientific Collaboration Projects

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LARC – USP
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USP University of São Paulo – Brazil
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** undergraduate programs.
  • **239** graduation Programs

Source: Anuário Estatístico 2013
ISI indexed papers: 31548
MIT: 35103
Yale: 35663

USP: Importance in Brazil

- USP: 24%
- Other Brazilian Univ.: 76%
- Other US Univ.: 87%
- U Texas + Harvard + UCLA + Stanford + Yale + MIT + Princeton: 13%
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
• **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)
L2 International Connections

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

Static L2 Circuit i2cat – USP (via RedCLara)

Situation as of May 2013

Source (adapted): Michael Stanton (RNP)
Fibre Island

Icarus node #8

... Wireless Network (OMF domain)

Icarus node #1

Pica8 Pronto Switch

IBM server (VMs, LDAP)

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

Fonte (adaptado): Michael Stanton (RNP)
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 & Dynamic Vlans for demos
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 Evaluation Committee
- 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
• **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)*
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 postgres 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
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
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

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

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

Use Cases:
Initially Physics Institute LHC Alice Experiment

Switch

perfSONAR Bandwidth

10G

10G

1G

10G

10G

10G

10G

Switch

perfSONAR Latency

RNP

ANSP

NAP/Terremark

Backbone USP

Border Router

USP Internal Network
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
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.
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


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

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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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