A Strategy for the Implementation of the Brazilian Academic Cloud

Referência
RIBEIRO FILHO, José L. et al. A Strategy for the Implementation of the Brazilian Academic Cloud. In: CLOUDSCAPE BRAZIL, 2014, Rio de Janeiro. **Position Papers**. [Rio de Janeiro]: EU Brazil Cloud Connect, 2014. p. 2 - 7.

Data de publicação
20-10-2014

Link
http://eubrazilcloudconnect.eu/sites/default/files/Booklet_PositionPapers_october2014_0.pdf

A Strategy for the Implementation of the Brazilian Academic Cloud

José L. Ribeiro Filho, Antonio C. F. Nunes, Gorgônio Araújo, Graciela M. L. Martins, Leandro M. O. Guimarães
Rede Nacional de Ensino e Pesquisa

Rio de Janeiro, Brazil

***Abstract*—This article presents a brief overview of the strategies currently adopted by some National Research and Education Networks (NREN) to implement and offer scientific cloud computing services. It describes the constraints, opportunities and the strategy chosen by the Brazilian NREN – Rede Nacional de Ensino e Pesquisa (RNP) to build and provide cloud services to and with public universities and research institutes in Brazil.**

Keywords— cloud implementation strategies, scientific cloud, cloud services middleware; National Research and Education Networks, hybrid and community cloud, federated cloud.

I. INTRODUCTION

The Brazilian National Research and Education Network (NREN) – Rede Nacional de Ensino e Pesquisa (RNP), is the organization that plan, design, deploy and operates a nationwide networking infrastructure under a contract with the Ministry for Science, Technology and Innovation (MCTI). A governmental program that currently includes four ministries – MCTI, Education (MEC), Culture (MinC) and Health (MS) defines, on an annual basis, the contract objectives and its funding. The four ministries are represented in a program governance committee, which supervises the program's execution. Among the program's objectives are the connection of university, research institutes, hospitals, museums, and many other public Research and Education (R&E) institutions through RNP's network infrastructure – *Rede Ipê*, shown in Figure 1.

Besides connecting more than 800 points, of around 350 public institutions (universities and research institutes) through an advanced multi-gigabit national backbone, and more than 35 optical metropolitan area networks (through owned infrastructure[1]), RNP also offers advanced services on top of this network, potentially benefiting more than 3.5 million users, including VoIP, web conferencing, video conferencing and telepresence rooms and services, VoD, live streaming, federated authentication for most of the services and eduroam. RNP also hosts in its data center several partner institutions' applications such as the *CAPES Portal de Periodicos* – a federated web portal which offers access to a large variety of international scientific journals to all public universities in the country.

One of the main goals of RNP's mission is to provide those and new advanced Information and Communication Technology (ICT) services to the Brazilian academic community. To achieve this goal, RNP is permanently seeking new technologies, products, services and processes, through partnerships and collaboration with the academy, industry and world's leading NRENs.

The ever increasing production of scientific data (e.g. environmental monitoring, biodiversity data bases, a variety of simulation and visualization systems like climate forecast, astronomy and cosmology, high energy physics data collection), cultural related data (e.g. historical and rare collections, audiovisual content, also as a means of data preservation) and management data (e.g. government ICT policies and R&E programs execution, assessment and management indicators, data bases and big data processing) require an scalable and sustainable data center infrastructure to support their demands. These facilities must be located in a distributed way and in places that offer telecommunication, energy and security services, as well as appropriate physical space/infrastructure. For most of the mentioned demands, the cloud computing technology and services can provide a cost effective solution.

Fig. 1. RNP's national network backbone – Rede Ipê

[1] REDECOMEP (Metropolitan Community Education and Research Networks) – a fiber optics infrastructure build by RNP in more than 35 cities to connect R&E institutions to RNP's backbone -. http://www.redecomep.rnp.br/

This paper presents the strategy defined by RNP to plan, deploy and operate cloud services to and in collaboration with Brazilian public universities and research institutes. The strategy is explained in the next sections, starting with a brief survey of current cloud strategies and services of other NRENs. The planning, deployment, operation and the pilot project are also discussed, taking into account the alternatives considered and the chosen options.

II. NRENs Cloud Strategies

Our work started with a survey that looked at what other NRENs are planning and doing, regarding their strategies about cloud computing services and infrastructure. Many NRENs are already offering cloud services in a variety of degrees and through different business models. However, in Europe, the Trans-European Research and Education Networking Association (TERENA) has been following closely the European NRENs strategies to offer storage/cloud computing services and infrastructure. Its annual TERENA Compendium [1] presents comprehensive information about all European and other NRENs in the world, where one can see how cloud computing deployment and services are evolving over time. Besides the annual compendium, TERENA also publishes studies produced by their working groups. A 2011 green paper which discussed the European NRENs strategic perspective on storage and cloud computing [2] was very influential in RNP's own cloud strategy definition, presented here.

The study considered two basic scenarios: a) universities and higher education institutes outsource services to public clouds or to their NREN; b) NRENs and research organizations outsource services or sub-services to public clouds; and a question to a panel of experts. "What kind of services, sub-services or functions can be outsourced by Universities and/or NRENs to public cloud service providers, how, and under what conditions and circumstances?"

The panel discussed issues such as privacy, application types (commodity and specialized), data protection, risks, costs, thrust (on public commercial providers x NRENs) and the conclusion was as follows:

- The outsourcing of commodity application services (e.g. student e-mails and document sharing) from universities to public clouds can be done with low risk. Moreover, significant cost benefits can be achieved through a NREN coordinated and centralized contracting process.

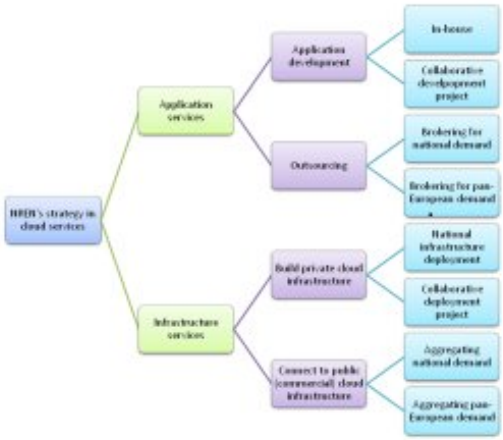
- For infrastructure related services (e.g. computing and storage) outsourcing to public clouds, it was considered that the risks concerning service operation, data protection, authentication and access control were an issue for individual universities. However, outsourcing these services to NRENs were considered acceptable, due to the established relationship and thrust between NRENs and universities.

- In case of the NREN itself, the outsourcing of commodity application services (e.g. calendar system) to commercial clouds seemed straightforward.

- Finally, for infrastructure related services (e.g. network operation, storage, videoconferencing, computing), the mixing of the NRENs own infrastructure with public clouds was considered a value-added IaaS scenario.

Figure 2 shows a simplified strategy decision tree for NRENs that came out of the TERENA discussions [2]. Regarding application services, NRENs can develop and provide their own services or can exploit the joint buying force of their users and brokering towards commercial cloud service providers. Regarding infrastructure services, NRENs can build their own cloud infrastructure or can aggregate user demands and channel them in to commercial cloud infrastructures.

Fig. 2. Cloud strategy decision tree



Based on user demands, networking capabilities, funding schemes and the above conclusions, NRENs have adopted three major national deployment strategies for e-infrastructure services offerings:

- building private storage/cloud infrastructure on top of the national R&E network;

- connecting public (commercial) storage/cloud infrastructure via the national R&E network;

- creating hybrid storage/cloud infrastructure (a mix of public and private infrastructures) connected via the national R&E network.

The next section presents RNP's cloud strategy, as planned and under deployment, based on the strategy options discussed above.

III. RNP Cloud Strategy

The cloud services/infrastructure strategy chosen by RNP came out of a process which was guided and constrained by the demands of the Brazilian R&E community, RNP operation and funding models, as explained in the introduction of this article, and other NREN cloud strategies discussed in the previous section.

Additionally, four main stakeholders that play major roles in the strategy definition and implementation were identified: public R&E institutions (universities and research institutes), research groups, RNP and R&E funding agencies. The

Brazilian academic cloud strategy was then built around those stakeholders. The R&D institutions can be, at the same time or separately, customers and providers of infrastructure and services. RNP has the coordination role, being responsible for the cloud architecture definition, contracting and operating its services, to develop and deploy applications, and the coordination of the partnerships with other stakeholders. The research groups contribute with their scientific application's requirements as well as with the development of new functionalities and the cloud funding, through and proportionally to their use of the cloud. Finally, the strategy includes the R&E funding agencies to help them promote a change in the current research funding model. The proposed funding model will take the portion of the money granted to research projects, destined to ICT infrastructure (including servers, storage and networking equipment, basic software and even some specialized applications), and transfer it directly to a National Scientific Cloud Program. Instead of having to build a usually expensive and fragile ICT infrastructure, which also takes time to buy and setup, granted projects will receive an equivalent quota of the required platforms as services from the national scientific cloud.

Another dimension considered in our work pointed out to two main classes of user profiles: institutional users (represented by IT managers of R&E institutions) and individuals (e.g. researchers and their labs). These two user classes have specific demands for cloud services and infrastructure, which can be grouped according to the three layers of cloud services: SaaS, PaaS and IaaS. Institutional users demand mainly SaaS services such as staff e-mail, student registration and storage/backup services. They may also want to mirror some parts of their local infrastructure to a private cloud, like virtual processors and raw storage, corresponding to the IaaS service. On the other hand, research groups show the desire to have more control over the cloud infrastructure, therefore requiring mainly an IaaS service, which allow them to develop, test and run their own applications and services on top of a virtualized infrastructure (e.g. processing, storage /backup and networking). They might also need PaaS services for collaboration projects using wiki, portals, data bases, etc. Besides these two user classes, RNP itself can migrate most of its current advanced services to the cloud infrastructure, including VoD/media streaming, web and videoconferencing, and some of its partners services like the *CAPES Portal de Periodicos*[2] scientific journal web portal.

As a result of the above described "environment" and NREN's major national deployment strategies for e-infrastructure services, discussed in the previous section, the best strategy that emerged for RNP's cloud service/infrastructure was a hybrid, community and federated cloud. The hybrid model allows RNP to act as a public (commercial) contract broker for "low risk" services, such as student e-mail, document sharing, etc. Through the community model, universities and research institutes can offer their own data center infrastructure (in full or partially) to the national cloud. They should be able to dynamically change the amount of resources shared with the national cloud and receive privileged access to other partner's infrastructure (virtual processors and storage) in return. Finally, the federated model ensures the required level of security and trustiness among all the partners as well as to the users through RNP's federated services. This strategy is also an answer to the geographical distribution requirement for a redundant and reliable cloud, once the partner institutions are distributed nationwide.

To make this model work seamlessly to the users and partners, a middleware is required to provide an isolation layer between the cloud service user interface, as well as the application program interface (API), and the specific physical and virtualized resources offered by the community/federated infrastructure providers, including contracted public (commercial) cloud providers. This middleware is still under development by various cloud computing research groups, such as the GT-PID: Distributed IaaS Platform [3] from Universidade Federal do Rio de Janeiro (UFRJ), based in open software platforms. It should be able to integrate the most common cloud platforms (e.g., Xen and vSphere Hypervisors) and orchestration software like OpenStack and CloudStack, in a transparent and easy way. The goal is to provide a high level abstraction layer to allow the integration of resources, and let users access cloud services and infrastructure unaware of its management and operation details. On the other hand, when required, users should be able to choose where they run their virtual machines/applications or move them from one cloud to another, regardless of where the cloud nodes are geographically located. The challenge to implement these features nowadays derives from the high heterogeneity of cloud provider's infrastructure. RNP is therefore modeling a service that should be able to use resources of as many cloud providers as possible, which requires supporting different Hypervisors and Orchestrators.

The strategy also includes other definitions like an Acceptable Use Policy (AUP) for the national cloud, the basic operation model (required to all partner institutions), the national cloud sustainability model, user interfaces and APIs, application migration support, to mention a few. Another concept defined in RNP's cloud strategy is the shared data center component, the CDC (Centro de Dados Compartilhados). The CDC is a physical structure that hosts all the required infrastructure for a Tier 2 data center, including redundant energy (also with power generators and UPS), fire control, independent cooling systems, unified management platform (that collects status of temperature, humidity, smoke, etc.), and access control systems. It can be a building or a container based platform, which can support rapid "horizontal or vertical" expansion.

IV. Implementation and Current Status

After the definition of the national cloud services and infrastructure strategy, RNP started in 2013 a pilot project, comprising the deployment of two container-based CDCs. The platform is the Huawei IDS1000 - C cluster container data center. It provides a flexible, mixing and modular design concept, committed to help customers to build the green cloud computing data center infrastructure, and realize the availability, safety, agility, scalability and an optimal TCO. The IDS1000-C can grow horizontally or vertically providing a

[2] http://www-periodicos-capes-gov-br.ez106.periodicos.capes.gov.br/

path for rapid infrastructure expansion. The hardware with the unified management software and the cloud platform were donated to the Brazilian government by the Chinese company. The smallest configuration comprises 2 container modules: one with the cooling and power generators/UPS and the other hosts the ICT platforms. It currently supports 132 processor cores and 0.5Pb storage. It is installed at the Instituto Nacional de Pesquisas da Amazônia (INPA) in Manaus. The other CDC has 3 container modules with separated cooling, power generators/UPS and ICT platforms. It supports 612 processor cores and 1.0Pb storage. They are installed at the Instituto Federal de Educação, Ciência e Tecnologia de Pernambuco (IFPE), in Recife, and is expected to start its assisted operation stage in July 2014.

Additionally, RNP's CDC project team is currently analyzing the integration of Huawei's software components with other Orchestration platforms, like CloudStack and OpenStack. The project team expects the cloud environment ready for the pilot phase by the end of October 2014. The CDCs will also be used to test the integration middleware that is being developed to support the hybrid, community and federated strategy model.

RNP is also discussing with some public universities and institutions (e.g. Cinemateca Brasileira) the partnership details that will allow them to enter and provide additional infrastructure to the national academic cloud. Besides this, RNP is comparing public/commercial cloud services, business models, pricing and contract clauses to start another pilot which will assess the broker role, as planned for the hybrid model.

V. Final Remarks

This paper presented a brief description of NREN's cloud strategies and the scenario chosen by the Brazilian National Research and Education Network, RNP, for the Brazilian academic cloud. The hybrid, community and federated strategy was chosen as the most flexible and suitable for the current Brazilian NREN operation and funding models.

RNP strongly believes that the Brazilian academic cloud will augment the security and the national sovereignty. It will also reduce current fragilities that many public R&E institutions demonstrate regarding the safety of an ever increasing amount of strategic and vital information, as a consequence of a lack of adequate e-infrastructure services and support.

Acknowledgment

The authors thank RNP and the Ministry for Science, Technology and Innovation for the support to the academic cloud program and the partners of the CDC project, including INPA, IFPE and Huawei.

References

[1] van Pinxteren, B., Editor; TERENA Compendium 2013: http://www.terena.org/activities/compendium/2013/

[2] Szegedi, P., NRENs' strategic perspective on storage and cloud "buy or build" (April 2011): http://www.terena.org/activities/tf-storage/Storage-and-cloud-v5.pdf

[3] GT-PID: Distributed IaaS platform: http://www.gta.ufrj.br/gt-pid/index.php/proj

[4] GT-CNC – Computação em Nuvem para Ciência (2012-2014) http://www.gt-cnc.gercom.ufpa.br/

[5] GT-MCC 2 – Minha cloud científica (realizado em 2012-2013) http://www.lncc.br/sinapad/projectmanager/public/projects/gt-mcc/wiki

[6] European cloud computing strategy: https://ec.europa.eu/digital-agenda/en/european-cloud-computing-strategy

[7] Boyle, Brian; Byrne, Ronan; Nisbet, Brian. HEAnet cloud strategy. TERENA Networking Conference 2014: https://tnc2014.terena.org/core/presentation/34

[8] Costa, R. E. O.; Brasileiro, F.; Lemos Filho, G.; Souza, D. M. T., Analyzing the impact of elasticity on the profit of cloud computing providers. Future Generation Computer Systems, v. 29, p. 1777-1787, 2013

[9] The adoption of cloud services (September 2012): http://www.terena.org/publications/files/"ASPIRE The Adoption of Cloud Services.pdf"

[10] SURFnet GigPort3 project, "Cloud Storage and Peer-to-Peer (P2P) Storage" http://www.surfnet.nl/nl/Innovatieprogramma's/gigaport3/Documents/conceptmap-v1.0.pdf

[11] SURFnet, "Connecting to cloud services - A guideline for NRENs", (November 2010) http://www.terena.org/mail-archives/tf-msp/pdfsIUEA3OSlJ.pdf

[12] Szegedi, P. at all, TERENA trusted cloud drive (May 2013) http://www.terena.org/publications/files/TERENA%20Trusted%20Cloud%20Drive%20Facility.pdf

[13] Jitcloudhttp://jitclouds.lsd.ufcg.edu.br/site/index.php/pt/publicacoes

[14] AutoStratushttp://www.dimap.ufrn.br/altostratus/publicacoes.php

[15] FileSender project http://www.filesender.org

[16] Peter Mell, Timothy Grance, "The NIST Definition of Cloud Computing (Draft)", (January 2011) http://csrc.nist.gov/publications/drafts/800-145/Draft-SP-800-145_cloud-definition.pdf

RNP
Ministério da Cultura
Ministério da Saúde
Ministério da Educação
Ministério da Ciência, Tecnologia e Inovação
GOVERNO FEDERAL BRASIL PÁTRIA EDUCADORA