National infrastructures for Future Internet Research and Development

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Abstract. *This paper features the GIGA testbed network [Scarabucci 2005] and the academic network Ipê [Stanton 2010], two of the most relevant networks in Brazil for the support of experimental research. It describes the characteristics and supported functionality of these networks, discusses their limitations and elaborates on how they can be evolved to support Future Internet research and development at various levels by way of large-scale experimentation.*

The GIGA testbed is a large-scale experimental network that can support experiments at any layer. The network has approximately 800km of fiber and interconnects almost 70 labs in 23 universities in 7 cities in the southeast region of Brazil. It currently consists of a static WDM layer and a 10G/1Gb Ethernet layer controlled by a GMPLS control plane, and it is connected to network Ipê and to experimental and academic international networks at transmission rates in the order of gigabits per second. In the near future the WDM layer will evolve to support dynamic reconfiguration and transmission rates of up to 100Gb/s, and the GMPLS control plane will control both layers in an integrated way. 10G OpenFlow-enabled Ethernet switches, currently under development, should gradually replace conventional Ethernet switches to support Future Internet experimental research. FlowVisor will be installed in the network to virtualize these OpenFlow Ethernet switches and, hence, allow for the harmonious coexistence of production traffic, multiple experiments with OpenFlow-based traffic and GMPLS-driven circuit traffic.

The Ipê network is the Brazilian national research and education network, operated by RNP, which provides connectivity to more than 300 institutions throughout Brazil, through PoPs (points of presence) in all 26 state capitals and the national capital. MPLS technology allows simultaneous use of this network for production IP traffic as well as L2VPNs for providing end to end level 2 circuits. The central high-speeed core of the Ipê network currently consists of 10 PoPs linked by 2.5 and 10 Gbps circuits.

By 4Q2010, a new version of this MPLS network will be deployed to reach 14 capitals at 10 Gbps and 10 capitals at 3 Gbps. By the same date, last mile

access to 26 out of 27 PoPs will be provided by wholly-owned optical metro networks, using 1 and 10 Gbps Ethernet links. This will enable at least 1 Gbps access to the more than 200 client institutions located in capital cities. A significant fraction of the capacity of the new Ipê network is intended to support level 3 network experiments, and will be used to extend the geographically limited coverage of the level 2/3 facilities of the GIGA testbed to institutions in the rest of Brazil, using L2VPNs for VLAN tunneling.

To enable international collaboration in experimental Future Internet research, the 20 Gbps of international connectivity which RNP shares with Fapesp-maintained networks in the state of São Paulo, will be used to enable the federation of the GIGA and Ipê experimental network facilities with similar resources in other countries.

References

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Biographies

Marcos Rogério Salvador obtained his Ph.D. degree in 2003 from University of Twente, in the Netherlands, and since then works for CPqD, where he is currently manager of technology evolution in the areas of optical communications, wireless communications, next-generation networks and electronic transactions. Over his years at CPqD, Marcos has coordinated and executed various high-budget R&D projects in optical networking technologies (e.g., optical packet/burst switching, optical control plane, traffic engineering, topology discovery), resulting in prizes, products transferred to companies, patents and dozens of papers published in scientific events and periodicals of relevance in the area.

Michael Stanton is Director of Research and Development at RNP. After a Ph.D. in mathematics at Cambridge University in 1971, he has taught at several universities in Brazil, since 1994 as professor of computer networking at the Universidade Federal Fluminense (UFF) in Niterói, Rio de Janeiro state. Between 1986 and 2003, he helped to kick-start research and education networking in Brazil, including the setting-up and running of both a regional network in Rio de Janeiro state (Rede-Rio) and RNP. He returned to RNP in 2001, with responsibility for R&D and RNP involvement in new networking and large-scale collaboration projects.