



Institute of Technology

Ciência sem Fronteiras / Science Without Borders

Postgraduate Project Template

Institution:	Waterford Institute of Technology
Title of Postgraduate Opportunity: (include level of study)	Network multi-homing, mobility and management in a Recursive InterNetwork Architecture
PI Name & Contact Details:	<p>Miguel Ponce de Leon and Martin Johnsson, Telecommunications Software & Systems Group (TSSG), ArcLabs Research and Innovation Centre, Waterford Institute of Technology, Carriganore Campus, Co. Waterford, Ireland.</p> <p>Email: miguelpdl@tssg.org / mjohnsson@tssg.org Tel: +353 51 302952 Mobile: +353 86 8590881</p>
Department/School:	Department of Computing Maths and Physics
Research Centre /Group:	Telecommunications Software & Systems Group
Research Centre/Group website:	www.tssg.org
Brief Summary of PI research / research group /centre activity <p>Miguel is currently the Chief Technologist at the Telecommunications Software & System Group in Waterford Institute of Technology. Miguel has participated in a number of national and international research and innovation ICT projects, and has authored and co-authored papers in the research themes of future networking, communication network management, smart grid and living labs. Miguel has been involved in commercialising research; most recently in innovating a new security technology for IP based video on demand systems. He has been the TSSG representative to ETSI and TMForum, and on the Advisory Council of ISOC; and contributed to 3GPP SA5 Telecommunication Management working group and in the area of Lawful Interception in 2001-2002. He is a WIT graduate, with a Diploma and Degree in Electronic Engineering (Hon).</p> <p>Waterford Institute of Technology (WIT) is a university-level institution in the South-East of Ireland with over 10,000 students and 1000 staff. The Telecommunications Software & Systems Group (WIT-TSSG) at Waterford Institute of Technology is Ireland's largest research centre in the Information and</p>	

Communication Technologies domain. The TSSG ethos is to build links between academic and industrial research through the creation of a balanced portfolio of activity in basic research, applied research and pre-product development. Initial work was on telecoms network management, but this has expanded since then to include mobility, trust and security, autonomies, software development tools, pervasive computing and multimedia. The group has a 14 year track record in research under Europe's IST/ICT framework programmes, with over 35 such projects to date.

Brief Description of Masters or PhD Project

The triumph of the TCP/IP protocol suite in today's market is nearly complete, however the research and industrial community has become skeptical about the current Internet's long-term sustainability. A monoculture of networking has emerged, based on protocols originally developed in the 1970s. With a near universal use of IP for purposes well beyond the original designers' intent, conventional wisdom holds that all future solutions must slowly evolve from it. This belief is not necessarily correct. TCP/IP has outlived its usefulness, for the Internet to prosper in the long term, it needs to move beyond TCP/IP.

Time has come for a renaissance in networking research, continuing the work of early pioneers like CYCLADES and INWG and leveraging the lessons learned during the last 40 years. A start afresh is needed, with an effort to go back to basics, finding out what is not understood to derive the fundamental principles in computer networking, the invariances that capture a fundamental theory.

This research project must embrace the basic premise that "networking is Inter-Process Communication (IPC) and only IPC", and must look at a network that is inherently more secure, simpler, supports multi-homing and mobility without the need of special protocols and open the door to richer markets and internetworking models.

Through this research project we propose to research, expand, deploy and validate the Recursive InterNetwork Architecture (RINA) architecture. This will be done through iterative cycles of research, experimentation and validation; leveraging existing multi-country testbed facilities.

RINA provides an architecture reference model and specifications that is closer to enable production deployments. The purpose of this research project will be to focus its research in the areas of i) network multi-homing and mobility; ii) network management, quality of service and policy-based configuration.

A reference implementation of the enhanced RINA specifications will be one of the project's main outputs.

Key Attributes of Project for Brazilian Postgraduate Students

The principles behind this project, RINA were first presented by John Day in his book "Patterns in Network Architecture: A return to Fundamentals" [1]. This work is a start afresh, taking into account lessons learned in the 40 years of TCP/IP's existence, as well as the lessons of OSI's [2] failure and the lessons of other network technologies of the past few decades, such as CYCLADES [3], DECNET [4] or XNS [5].

Since the theory behind RINA was published in the PNA book, world-wide research work has started to investigate the properties of the RINA model and develop early prototypes of components of RINA. For example

- May 2009. The Pouzin Society (PSOC) announces its first organizational meeting. PSOC is an international effort that groups under a common umbrella all the activities around RINA research, prototyping and promotion. The initial milestone of PSOC was set to develop RINA specifications that could enable the implementation of a DIF providing a service equivalent to TCP/IP.
- October 2009. An initial draft of the RINA specifications is made available through the PSOC mailing list. The specifications are a first attempt to formalize the RINA architectural reference model and provide an initial description of the different components required to implement it.
- April 2010. A research group at Boston University, led by John Day and Ibrahim Matta, receives an award from the National Science Foundation for RINA research.
- May 2010. Second PSOC meeting, collocated with the FutureNet conference. Results of ongoing RINA research are presented, RINA is debated as a viable alternative to IP within an audience formed mostly by service providers and network hardware vendors.
- July 2010. The TSSG and i2CAT announce their participation in PSOC by joining the RINA prototype initiative. Both institutions will develop together a prototype as a means of further researching RINA and contributing to the milestone of completing the initial RINA specifications for a basic DIF service.
- December 2010. Third PSOC meeting, the first one celebrated in Europe. PSOC members plan the activities for 2011, and start preparing the strategy to increase the number of institutions (both from industry and academia) involved in RINA research and development. Part of the strategy is completing the initial draft specifications and prototype.
- November 2011. Fourth PSOC meeting is held in Europe, PSOC membership has increased with a number of equipment vendors, operators and system integrators attended the technical workshop.
- June 2012. Initial prototype implementation of the base RINA specification is released as open source on GitHub.

Software Defined Networking (SDN) and OpenFlow are also factors within this research space. SDN is a concept that indicates that network devices should provide “standard APIs” so that the device’s behavior can be programmed through software. The first implementation of the SDN concept is the OpenFlow Protocol, which provides an API to directly access and modify the forwarding table of a network element. The control gained over the forwarding tables is an advantage but it is definitely not the only part that can be configured. RINA provides a theory of what are the minimal common elements required in all forms of computer networking (mechanisms) and a framework for defining and plugging in/out all the elements that are configurable and optional (the policies), all within an architecture based on a sound theory of networking.

It is clear that today’s societal lifestyle is intimately tied to the usage of the Internet, an internetwork architecture like RINA, further researched, validated and improved by this research project, capable of overcoming the current Internet shortcomings, we believe has deep social and economic implications. Highly-sophisticated distributed applications are everywhere: cloud computing, e- health, e- government, social networks, online gaming, peer-to-peer, and e-learning. For example in the global financial system (New York, London, Frankfurt, Tokyo stock exchanges) today all stock trading is done virtually, through massive, globally interlinked computer systems. The rates of these transactions are now limited only by the IP network they transit over and traditional operator-centric business models. Stock traders are looking for a competitive edge as small as a few tens of microseconds, and this is due to the recent uprise in high-frequency trading. The computerised trading platform of a high-frequency trading firm buys and sells financial instruments while holding on to them for perhaps just fractions of a second. The money is made by exploiting tiny and fleeting disequilibriums in the markets, for example, when the price of one asset changes (in New York) and the price of another (London) that should be

equivalent in value does not change immediately to match. ICT networking and research networking across the globe will be key to advance this scenario.

- [1] John Day. Patterns in Network Architecture: A Return to Fundamentals. Prentice Hall, 2008.
 [2] H. Zimmermann. Osi reference model: The iso model of architecture for open systems interconnection. IEEE Transactions on Communications, 28(4):425–432, 1980.
 [3] L. Pouzin. Presentation and major design aspects of the cyclades computer network. Proceedings of the NATO Advanced Study Institute on Computer Communication Networks, pages 415–434, 1973.
 [4] Distributed Data Processing Group Digital Equipment Corporation. DECnet technical summary, 1980.
 [5] Xerox Systems. Internet transport protocols, xsis 028112, 1981.

Name and contact details for project queries, if different from PI named above:

Please indicate graduate disciplines which are eligible for application: Computer Science, Distributed Systems, Telecommunications

Alignment with Science Without Borders Priority Areas:

Please indicate the specific programme priority area under which the proposed postgraduate project fits – choose only one (tick box)

Engineering and other technological areas	
Pure and Natural Sciences (e.g. mathematics, physics, chemistry)	
Health and Biomedical Sciences	
Information and Communication Technologies (ICTs)	X
Aerospace	
Pharmaceuticals	
Sustainable Agricultural Production	
Green Chemistry	
Oil, Gas and Coal	
Renewable Energy	
Minerals	
Biotechnology	
Nanotechnology and New Materials	
Climate Change	
Biodiversity and Bioprospection	
Marine Sciences	
Productive Inclusion and Social Technologies	
Housing and Sanitation	