Report from Conferences and Research Labs visited in Europe in connection with PlanetLab NZ program (20 May-11 June, 2010)

By

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INTRODUCTION:

I am thankful to the Department of Computer Science & Software Engineering at the University of Canterbury, REANNZ, and Professor Dr. Krys Pawlikowski in particular, for awarding me a conference travel scholarship for attending two research conferences on theoretical foundations of Future Internet and the issues of its performance. The two conferences which I attended were:

1. TRIDENTCOM 2010 (6th International Conference on Testbeds and Research Infrastructures for Development of Networks & Communities, held in Berlin, Germany from 17 May 2010 to 20 May 2010)

2. Workshop on Stochastic Processes in Communication Networks for Young Researchers (organized by International Centre for Mathematical Sciences & Cambridge University, held in Edinburgh, UK from 7 June 2010 to 11 June 2010).

Apart from these two conferences, Prof. Krys Pawlikowski also arranged my visits in:

1. the Telecommunication Networks Group of Professor Adam Wolisz at Department of Electrical Eng. & Computer Science, Technical University of Berlin, Germany; and
2. the AESOP (Analysis, Engineering, Simulation & Optimization of Performance) Research Group of Professor Peter Harrison at Department of Computing, Imperial College, London, UK

I am thankful to PlanetLab New Zealand program for awarding me full financial support for this leave. I am also thankful to Prof. Tanja Mitrovic (Head of the CSSE Department) for issuing me a letter which helped me to obtain my UK visa .

TridentCOM 2010:

The Testbeds and Experimental Facilities for the Future Internet will play a pivotal role in designing future networks, therefore there is a number of conferences which devote significant attention to these issues. TridentCom is one of the reputed and leading conferences in this arena. This conference every year provides a forum to explore existing and planned testbed concepts, research infrastructures and tools to address the current challenges in a world of global network convergence. The l conference was held in Berlin's Hotel Golden Tulip. The conference lasted 4 days and had the following program:

Day 1: TridentCOM Offsite Tutorial
Day 2: TridentCOM Onsite Tutorials
Day 3: TridentCOM Sessions
Day 4: TridentCOM Sessions

The details are the technical program of these days is discussed below.

Day 1: TridentCOM Offsite Tutorial

An offsite tutorial was organized at the Technical University of Berlin, with the collaboration of Fraunhofer FOKUS Institute. The title of this tutorial was "Towards the Wireless Future Internet - Understanding the role of future mobile broadband networks and the Evolved Packet Core".

This half day tutorial provided an overview of the future mobile networks and the corresponding 3GPP standards related to the Long Term Evolution (LTE) and the Evolved Packet Core (EPC), which are seen as forming the Evolved Packet System (EPS) in future networks. Major focus of this tutorial was on the EPC concepts, architecture, components, interfaces and functional capabilities. As the EPC provides a unified control platform for linking different IP application platforms with various broadband wireless access networks, the tutorial also addressed potential EPC application domains, namely the IP Multimedia Subsystem (IMS), as well as potential open Internet service architectures.

The tutorial terminated with an introduction to OpenEPC (http://www.openepc.net), a software toolkit enabling rapid prototyping of software solutions for applied academic and industry research projects designed by the TU Berlin and the Fraunhofer FOKUS Institute. In particular, we were introduced to the new open Future Seamless Communication Playground (http://www.fuseco-playground.org) established at the beginning of 2010.

Day 2: TridentCOM Onsite Tutorials

There were 4 tutorials that day, in two parallel streams. I attended the following tutorials:

1. Getting started with Teagle - A FIRE testbed federation tool
2. Future Internet Technologies

The details are as under:

1. **Getting started with Teagle - A FIRE testbed federation tool**

Teagle is the central coordination and testbed deployment engine used for Panlab, a large scale federated experimental facility. Teagle allows the setup of distributed testbeds using ICT resources provided by Panlab. Such resources include general purpose machines, dedicated hardware or complex software systems, such as the IP Multimedia Subsystem (IMS) core system for NGN related testbeds, and/or the Evolved Packet Core (EPC) for Mobile and Fixed NGN related testbeds, and/or various generic application enablers.

The resources can be booked and configured upon demand, serving specific testing or experimentation needs. Users of this facility and its underlying infrastructure usually are research and development teams or individuals from industry and academia.

My Feedback:

At the end of the first tutorial I asked for explaining the difference between Teagle and the NEPI framework (Network Experimentation and Programming Interface, under development at INRIA France). Since the tutorial's presenter did know the details about NEPI, I explained that NEPI is a utility which can provide a single programming and controlling interface for various Internet testbeds, such as PlanetLab,EmuLab, OrbitLab etc, with support of NS3 simulator. Upon a request I emailed the NEPI paper[1] to the participants. Next day, the research team of FOKUS Institute admitted that Teagle is similar to NEPI but it lacks NS3 support. Later, I have found that it also lacks a support for real interaction with any existing testbed, such as PlanetLab.

2. **Future Internet Technologies**

The Internet today is a complex agglomerate of protocols that inherits the grown legacies of decades of patchwork solutions. One can observe an explosion of network management costs. Security problems are more pressing than ever. At the same time application and user demands of services over the Internet are increasing with mobile technologies and media content on the rise all, while the number of participating nodes is equally boosting.

As a direct consequence research programs have started worldwide to re-think traditional Internet design principles and to come up with new architectural concepts for the Future Internet. Various programs in the US, Europe and Asia supplement theoretical research with federated large-scale facilities for experimental research.

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1. Lacage, M., Ferrari, M., Hansen, M., Turletti, T., and Dabbous, W. 2010. " NEPI: using independent simulators, emulators, and testbeds for easy experimentation". *SIGOPSOper.Syst.Rev.*43,4 (Jan.2010), 60-65. DOI= http://doi.acm.org/10.1145/1713254.1713268

The Future Internet Tutorial provided an overview of evolutionary and revolutionary (clean slate) Future Internet research directions and trends. It presented the FutureInternet research initiatives existing around the world and the efforts to establish experimental facilities for FI research. The tutorial gave an introduction to Future Internet technologies that are currently under discussion. Among the approaches discussed were new addressing and routing concepts beyond IPv6, Network Virtualization, Functional Composition, Autonomic Communication and new network types.

Day 3 and Day 4: TridentCOM Sessions

In the last two days, various research papers were presented in the form of two parallel sessions, each half of the day. I attended the following paper presentations:

1. "How to Build Complex, Large-Scale Emulated Networks", by Olaf Maennel (Loughborough University), Randy Bush (IIJ), Simon Knight (University of Adelaide), Nick Falkner (University of Adelaide), Matthew Roughan (University of Adelaide) and Hung Nguyen (University of Adelaide).

2. "A Novel Testbed for P2P Networks",byPekka Perälä (Technical Research Centre of Finland (VTT)), Jori Paananen (Technical Research Centre of Finland (VTT)), Milton Mukhopadhyay (Pioneer Digital Design) and Jukka-Pekka Laulajainen (Technical Research Centre of Finland (VTT)).

3. "A Testbed for Validation and Assessment of Frame Switching Networks" by Arthur Mutter (Institute of Communication Networks and Computer Engineering, University Stuttgart), Sebastian Gunreben (Institute of Communication Networks and Computer Engineering, University Stuttgart), Wolfram Lautenschläger (Alcatel-Lucent Deutschland AG, Bell Labs, Stuttgart, Germany) and Martin Köhn (Institute of Communication Networks and Computer Engineering, University Stuttgart).

4. "Experimental Evaluation Of OpenVZ From A Testbed Deployment Perspective" by Gautam Bhanage (WINLAB, Rutgers University), Ivan Seskar (WINLAB, Rutgers University), Yanyong Zhang (WINLAB, Rutgers University), Dipankar Raychaudhuri (WINLAB, Rutgers University) and Shweta Jain (WINLAB, Rutgers University)

5. "Port-space Isolation for Multiplexing a Single IP Address through Open vSwitch" by Ping Du (NiCT, Japan), Maoke Chen (NiCT, Japan) and Akihiro Nakao (The University of Tokyo, Japan)

6. "FEDERICA: a virtualization based infrastructure for future and present Internet research", by Campanella Mauro (GARR)"Towards a Virtualized Sensing

Environment" by David Irwin (University of Massachusetts, Amherst), Navin Sharma (University of Massachusetts, Amherst), Prashant Shenoy (University of Massachusetts, Amherst) and Michael Zink (University of Massachusetts, Amherst).

7. "ETOMIC Advanced Network Monitoring System for Future Internet Experimentation" by Peter Haga (Eotvos Lorand University), Attila Fekete (Eotvos Lorand University), Eduardo Magana (Universidad Publica de Navarra), Daniel Morato (Universidad Publica de Navarra), Javier Aracil (Universidad Autonoma de Madrid) and Francisco Gomez (Universidad Autonoma de Madrid).

8. "Characterizing User Behavior and Network Load on a Large-scale Wireless Mesh Network" by Fabrizio Granelli (University of Trento), Roberto Tomasi (Futur3 srl), Michele Vincenzi (Futur3 srl), David Tacconi (Futur3 srl) and Dzmitry Kliazovich (University of Trento).

9. "A Zero-Nanosecond Time Synchronization Platform for Gigabit Ethernet Links" by Carles Nicolau (Universitat Pompeu Fabra).

10. "The DORII Project e-Infrastructure: Deployment, Applications, and Measurements" by Franco Davoli (University of Genoa), Davide Adami (University of Pisa, Italy), Alexey Cheptsov (HLRS, University of Stuttgart, Germany), Bastian Koller (HLRS, University of Stuttgart, Germany), Matteo Lanati (EUCENTRE, Pavia, Italy).

11. "Experimental Validation and Assessment of Multi-domain and Multi-layer Path Computation" by Joachim Scharf (Universitaet Stuttgart, IKR), Sebastian Gunreben (Universitaet Stuttgart, IKR), Ramon Casellas (Centre Tecnologic de Telecomunicacions de Catalunya).

12. "Virtualized Application Networking Infrastructure" by Hadi Bannazadeh (University of Toronto), Paul Chow (University of Toronto), Saleh Dani (University of Toronto), Mingliang Ma (University of Toronto), Arbab Khan (University of Toronto).

13. "The Network Testbed Mapping Problem" by Rick McGeer (HP Labs), David Andersen (Department of Computer Science, Carnegie-Mellon University), Stephen Schwab (Cobham Analytic Solutions).

14. "Managing Distributed Applications using Gush" by Jeannie Albrecht (Williams College), Danny Yuxing Huang (Williams College).

15. "Interoperability of Lightpath Provisioning Systems in a Multi-domain Testbed" by Alfred Wan (University of Amsterdam), Cees de Laat (University of Amsterdam), Paola Grosso (University of Amsterdam).

16. "The Great Plains Environment for Network Innovation (GpENI): A Programmable Testbed for Future Internet Architecture Research" by James Sterbenz (The University of Kansas), Haiyang Qian (University of Missouri - Kansas City), Ramkumar Cherukuri (University of Missouri - Kansas City).

17. "FIT: Future Internet Toolbox" by Thorsten Biermann (University of Paderborn), Christian Dannewitz (University of Paderborn), Holger Karl (University of Paderborn).

18. "Distributed ontology-based monitoring on the IBBT WiLab.t infrastructure" by Stijn Verstichel (Ghent University - IBBT), Eli De Poorter (Ghent University - IBBT), Tim De Pauw (Ghent University - IBBT), Bruno Volckaert (Ghent University - IBBT).

19. "FLAME: Flexible Lightweight Active Measurement Environment" by Artur Ziviani (LNCC), Antônio Tadeu Gomes (LNCC), Marcos Kirszenblatt (LNCC), Thiago Cardozo (LNCC).

20. "TopHat: supporting experiments through measurement infrastructure federation" by Thomas Bourgeau (UPMC/LIP6), Jordan Augé (UPMC/LIP6), Timur Friedman (UPMC/LIP6).

COMMENTS:

All presented papers were of great value. I found some papers related to my research area i.e related to active measurements. I also had discussions with the authors of these papers. These papers are related to FLAME: a Flexible Lightweight Active Measurement Environment, TopHat: a measurement infrastructure for federated testbeds, Future Internet Tool box, and Network Testbed Mapping problem.

VISIT AT TELECOMMUNICATION NETWORKS (TKN) RESEARCH GROUP OF TECHNICAL UNIVERSITY OF BERLIN

On 17th May 2010, Prof. Krys Pawlikowski arranged my visit at TKN research group headed by Prof Adam Wolisz at Technical University of Berlin. I met students at TKN group and discussed some research issues related to Future Internet. I am especially thankful to Daniel Wilkommm who was my host there. Daniel discussed with me research ideas related to wireless future Internet as he is doing his PhD on wireless aspects of Future Internet. He also showed me the access points of wireless testbeds deployed at TKN Laboratory.

VISIT AT ANALYSIS, ENGINEERING, SIMULATION & OPTIMIZATION OF PERFORMANCE (AESOP) RESEARCH GROUP OF IMPERIAL COLLEGE LONDON.

On 25th May 2010, Prof. Krys Pawlikowski arranged my visit at the AESOP Research Group of the Imperial College in London, headed by Prof. Peter Harrison. I discussed my prospective research topics with him and he advised me to study time series analysis and hidden Markov models if I were going towards Internet traffic analysis and prediction. He also suggested me some books on these topics. Professor Harrison appreciated the idea of using PlanetLab for experimentation instead of simulation which always require validation.

WORKSHOP ON STOCHASTIC PROCESSES IN COMMUNICATION NETWROKS FOR YOUNG RESEARCHERS AT EDINBURGH UK.

This workshop was a part of a larger program on Stochastic Processes in Communications Sciences run by the Isaac Newton Institute of Cambridge University. This program originated at the International Centre for Mathematical Sciences (ICMS) in 1990 The core purpose of the ICMS is the development and organization of international workshops and conferences in the mathematical sciences, and in particular:

- To create an environment in which mathematical sciences will develop in new directions
- To encourage and exploit those areas of mathematics that are of relevance to other sciences, industry and commerce
- To foster closer collaboration between departments of mathematical sciences

The workshop on stochastic processes was mainly intended for young researchers like PhD students and post-doc researchers who intend to analyze communication networks by means of stochastic models. This was a highly mathematical workshop and advance stochastic analysis techniques were presented, with an emphasis on their applications in telecommunication networks and heavy traffic analysis. Old concepts, current practices and the latest developments were presented by well know researchers in these areas. The major focus was on advanced queuing theory, graph theory and percolation theory. The workshop slides are available at http://www.icms.org.uk/workshop.php?id=111#arrangements

I was especially impressed by talks given by Professor Remco van der Hofstad (Eindhoven University of Technology) and Professor Philippe Robert (INRIA, France). Professor Remco gave a series of lectures on "Processes on random graphs: routing and attack vulnerability" and Professor Philippe Robert gave a series of lectures on "Probabilistic methods in the analysis of stochastic networks".

Exposure to random graph theory and relevant stochastic processes has helped me to adjust the direction in which I can apply the prospective outcomes of my research, especially in the area of optimal resource allocation in cloud computing environment.

CONCLUSION:

Having attended the two conferences and two groups well known for their research in the area of telecommunication networks, I have returned to Christchurch full of new research ideas and experiences. The knowledge gained during this travel has greatly helped me in preparing my doctoral research proposal which since then has been approved by the University of Canterbury.

The title of my approved proposal is "Online Performance Evaluation of Future Internet and its Applications". This research project will be composed of three phases. First phase will be related to designing or optimizing existing strategies of accurate active measurements to collect network performance parameters over PlanetLab. The second phase will consist of online analysis to estimate important parameters of self-similar traffic (a such as H parameter). The third phase will consist of developing prediction models of teletraffic. The research issues of this PhD research can be further extended to include possible optimization of resource allocations in cloud computing.

I would like to thank again for granting me this scholarship.