

# ERCIM “Alain Bensoussan” Fellowship Scientific Report

Fellow: Audrius Jurgelionis  
Visited Location : NTNU, Norway  
Duration of Visit: 12 months, 01/11/2010 – 31/10/2011  
Scientific Coordinator: Alf Inge Wang

## **I - Scientific activity**

The ERCIM postdoctoral fellowship was carried out within the Software Engineering Group at the Department of Computer and Information Science. As a member of the Software Engineering Group I was entitled to attend the group’s meetings, propose and supervise master’s projects, and granted access to all the NTNU’s facilities that are available for a postdoctoral fellow.

Performed scientific research activities can virtually be outlined into separate categories that are detailed below.

Research activities related to the previous PhD work on distributed gaming system design and testing led to the production of two papers [1 and 2]. A study in paper [1] evaluated the main functionalities of NetEm, a popular Linux based network emulator, which was used to stress test the performance of the Games@Large distributed gaming system. During the first exchange visit to VTT this study has been extended to test a hardware based network emulator and two different configurations of the NetEm emulator. The experience acquired during this experiment will hopefully allow defining a simple but effective methodology for network emulator testing and validation. This would enable to assure that the functionality of network emulators is flawless and that it allows obtaining reliable test results. Paper [2] presented an in-depth quantitative study performed with the Games@Large distributed gaming system and its potential users at an Internet café in Genoa, Italy. The methodology and findings of the GaL system tests can be applied to similar game streaming systems and used as input for theories on social digital game play.

Research related to the design of the framework enabling easy pervasive game development has been a continuation of the work within the MOSS project at NTNU. The main goal of the project is to establish models, architectures and prototypes for mobile and social games. A study of the state of the art technologies and analysis of the NTNU’s existing work on modelling based pervasive game development and conceptual game framework enabled defining relevant research directions. These were later discussed and refined during the second exchange visit to Fraunhofer FIT. Finally, with a strong support from the NTNU’s colleagues, a new general game play model and authoring tool for construction of pervasive games have been proposed. The authoring tool is targeting non-technical users and is intended for integration with other software tools and underlying platforms to build a powerful framework for pervasive game development. The results have been published in paper [3]. Further collaboration with the NTNU’s team on the framework development will hopefully continue also in the near future.

Finally, some research efforts have been devoted to study pervasive game applications in vehicles as well as in-vehicle multimedia and consumer electronics device design and integration with the focus on road safety. Currently, paper writing is in progress and will include some of the research outcome and a proposal of a conceptual framework for in-vehicle interactive multimedia design and testing.

## **II- Publication(s) during your fellowship**

[1]. A. Jurgelionis, J.P. Laulajainen, M. Hirvonen, and A. I. Wang, "**An Empirical Study of NetEm Network Emulation Functionalities**", ICCCN 2011 Workshop on Performance Modeling and Evaluation in Computer and Telecommunication Networks, Maui, Hawaii, July 31- August 4, 2011

**Abstract:** In this paper we have evaluated the main functionalities of NetEm, a popular Linux based network emulator, which we have used to stress test the performance of the Games@Large distributed gaming system. We have performed a number of tests on different NetEm functionalities in order to evaluate their practical performance conformity and validity versus the NetEm description and theoretical expectations. We have found that the NetEm behaviour conforms to expectations for the emulation of delay and packet loss without correlation. However, in the case of jitter emulation, the actual realized jitter is lower than the given input value. It is an important fact to be aware of when using NetEm for different application testing. This paper also provides a baseline methodology for network emulation tool validation.

[2]. A. Jurgelionis, H. H. Nap, B.J. Gajadhar, F. Bellotti, A. I. Wang, and R. Berta, "**Player Experience and Technical Performance Prospects for Distributed 3D Gaming in Private and Public Settings**", Accepted for ACM Journal Computers in Entertainment (CIE), 2011

**Abstract:** Distributed gaming enables a pervasive access to interactive media from devices based on different platforms. It facilitates users to enjoy video games in various environments without the need for using a single device or operating system. Understanding the potential and limitations of such gaming on demand systems is key for their adoption and further growth in public places. This paper presents an in-depth quantitative study performed with the Games@Large (GaL) distributed gaming system and its potential users at an Internet café in Genoa, Italy. The approach of the study was multilevel, covering the player experience and user acceptance aspects as well as technical performance peculiarities. Results show that the GaL system has a high potential at Internet cafes, in particular when playing a casual genre game. Furthermore, results provide recommendations for deploying such systems in terms of social setting and technical aspects. The methodology and findings of the GaL system tests can be applied to similar game streaming systems and used as input for theories on social digital game play.

[3]. A. I. Wang, A. Jurgelionis, H. Guo, H. Trætteberg, "**Designing Enhanced Authoring Tools for Pervasive Games**", Accepted to the 3rd Workshop on Mobile Gaming (Moga 2011) at ACE & DIMEA 2011, Lisbon, Portugal, 8-11 November, 2011

**Abstract:** This paper describes a general game play model and authoring tool for construction of pervasive games. The proposed game play model is relying on the definition of common constructs among a range of pervasive game categories that are broken down into atomic game elements that are later used to build various games. Further, the paper presents design of a platform independent authoring tool, focusing on the GUI and its easiness to use, and envisions a possible implementation for the described game play model. The authoring tool targeting non-technical users and is intended for integration with other software tools and underlying platforms to build a powerful framework for pervasive game development.

### **III -Attended Seminars, Workshops, and Conferences**

1. MeeGo Conference 2010, Dublin, Ireland, 15-17 November, 2010
2. Norwegian Language Course 1 and 2, Folkeuniversitetet, Trondheim, February-May 2011.
3. Teacher Training Seminar for PhD students and Post-Doctoral Research Fellows, Spring 2011. NTNU, Trondheim, 25/05, 7/06 and 10/06/2011.
4. 20th IEEE International Conference on Computer Communications and Networks, ICCCN 2011, Maui, Hawaii, 31/07-4/08/2011
5. gamescom 2011, Trade fair for interactive games and entertainment, Cologne, Germany 17-21/08/2011

### **IV – Research Exchange Programme (12 month scheme)**

**First Exchange Visit:** VTT Technical Research Centre of Finland in Oulu, Converging Networks Laboratory

Scientific Contact: Jukka-Pekka Laulajainen, Jukka-Pekka.Laulajainen@vtt.fi

Duration of Visit: 29/05/2011 - 04/06/2011.

The main goal for this visit was to perform tests with a prototype of hardware based network emulator. In addition, two different setup configurations with the NetEm emulator were prepared for tests in order to extend the work performed within the empirical study of NetEm network emulation functionalities. During the visit relevant test scenarios were defined and measurements performed for all the three tested network emulator configurations.

The visit also included an introduction to the VTT converging networks laboratory and its staff, as well as a presentation of my research activities in a seminar.

**Second Exchange Visit:** Fraunhofer FIT in Sankt Augustin, Cooperation Systems Department

Scientific Contact: Leif Oppermann, leif.oppermann@fit.fraunhofer.de

Duration of Visit: 18/08/2011 - 24/08/2011.

The main goal for this visit was to discuss possible research directions related to the creation of a framework for the development of pervasive games (within the context of the MOSS project at NTNU). The TOTEM project at Fraunhofer FIT has a similar aim, to develop a complete framework for enabling easy creation of mobile mixed reality games. Thus discussions with people working on this project enabled identifying conceptual challenges that are related to the creation of the game logic model. On the other hand they further led to the definition of some technical implementation requirements and difficulties.

The visit also included an introduction to the Fraunhofer FIT Cooperation Systems Department and Mixed and Augmented Reality Solutions Group, its staff and the on-going projects, also a visit to the Fraunhofer FIT's exhibition booth at the gamescom 2011 trade fair.