# ERCIM "Alain Bensoussan" Fellowship Scientific Report

Fellow:              Peter Karpati
Visited Location :   Norwegian University of Science and Technology (NTNU),
                     Trondheim
Duration of Visit:   03.09.2007 – 02.09.2008

## I - Scientific activity

My work covered two fields during the fellowship. The first included the extension of my PhD research in cooperation with my former colleagues and connected publications. This work is in the area of distributed video servers, using offensive adaptation techniques. The other field was healthcare informatics and I worked on a messaging system to support healthcare professionals in hospitals. This work was done in cooperation with colleagues from NTNU in Trondheim. Regarding the video server research, the formal model of a video-on-demand system and its required configuration recommendation algorithms were developed further and some new measurements were executed. The publications listed in the next section include unpublished results from my thesis work and new results based on that from this year. This was not the primary research subject for the research group in Trondheim; more details can be found in the abstracts.

As a main activity, I became acquainted with the field of healthcare informatics and investigated how health professionals in hospitals cooperate with each other. Because communication is the primary way in which collaboration among them is achieved, I focused with my colleagues on computer technology that can support communication, namely on mobile messaging. However, the main requirements for such systems are still to be formulated. To make the first steps towards this direction, we revisited two observational studies that focused on clinicians' information and communication behavior. We developed a simple analytical framework and drew some conclusions regarding the distribution of observed instances of communicative acts over the different types we distinguished. This was used later to formulate some high level requirements for communication support. Based on that and on visits at the cardiology department of a local hospital, we designed two messaging system prototypes: one for support examination planning and the other for managing medications. After paper-based prototyping sessions, the simple versions of the systems were built and their usability tested. We faced limitations on the amount of time that we could gain access to the healthcare professionals and the hospital wards, yet we were able to complete our goal of finishing the first exploratory phase of this work. Currently, we are working on 1) widening our knowledge of the communication requirements within and between different wards, 2) involving more health experts, and 3) building a more general model of the communication support system based on an ontology we developed for collaborative creative/care activities.

## II- Publication(s) during your fellowship

Conference papers

(1) Tibor Szkaliczki, Péter Kárpáti, László Böszörmenyi, *Algorithms for Placement of Storage components and Videos in Distributed Multimedia Servers*, Accepted for IASTED, CSN 2008 (The 7th IASTED International Conference on Communication Systems and Networks)

*Abstract.* We plan to setup a VoD service built on an innovative multimedia server architecture which enables dynamic adaptation to the changing circumstances. The adaptation happens by replicating the server components and the stored videos based on real-time host and network monitoring and resource constraint analysis. In addition, the terminal capabilities and client preferences are considered. We developed a simulation environment for assisting in the design and evaluation of self-organising video servers. The paper focuses on the challenge of the optimal placement of storage components and the videos in the network. We implemented and compared three algorithms for host recommendation (so called simple, incremental and complex incremental); the latter one can be calibrated against different preferences. The algorithms were integrated into the simulation system. We examined the effect of changing weights of the complex incremental algorithm onto the recommendation.

(2) Péter Kárpáti, Tibor Szkaliczki, László Böszörmenyi, *Modeling and Simulation of the Performance of Distributed Video Services*. Accepted for Networks 2008 (13th International Telecommunications Network Strategy and Planning Symposium)

*Abstract.* To characterize the potential performance of servers regarding their services (e.g. for comparison issues) we need to extract the essential features of the underlying networks. Two network models are presented which serve as base for performance evaluation of VoD servers. The first one is a formal model focusing on LANs which contains mathematical functions characterizing the infrastructure and possible throughput of a server. The second one is part of a simulation environment which enables the comparison of video servers. At the end of the paper, a short summary of a performance study is presented as a demonstration which introduces some network related metrics as well.

(3) Péter Kárpáti, Tibor Szkaliczki, László Böszörmenyi, *Comparing static and self-organizing behaviours for VoD servers*. Accepted for IASTED, IMSA 2008 (The 12th IASTED International Conference on Internet and Multimedia Systems and Applications)

*Abstract.* A simulation environment was developed which can assist in the design and evaluation of video server and their algorithms. Three behaviour strategies of video servers were compared by the simulation: a static one and two self-organizing ones with different level of elasticity. Three performance measures were applied: number of served requests, client satisfaction, and one related to service quality and network load. The study involved almost 113000 video requests per simulation run and altogether 168 runs. The results indicate that self-organizing behaviour can bring significant improvement in an environment with restricted resources. If the resources are too restricted or hardly restricted, the static behaviour shows a small advantage over self-organizing.

Journal paper

(4) Péter Kárpáti, Tibor Szkaliczki, László Böszörmenyi, *Designing and scaling distributed VoD servers*, accepted by MULTIMEDIA TOOLS AND APPLICATIONS (Springer)

*Abstract.* Planning Video-on-Demand (VoD) services based on the server architecture and the available equipment is always a challenging task. We created a formal model to support the design of distributed video servers that adapt dynamically and automatically to the changing client demands, network and host parameters. The model makes giving estimations about the available throughput possible, and defines evaluation criteria for VoD services relating to utilization and load balance, video usage, client satisfaction and costs. The dynamism of the frame model originates from the possible state transitions which have to be defined in a core

model. The core model is responsible for configuration recommendation which determines how clients are served depending on the properties of their requests, system configuration and system load. Furthermore, it decides on the optimal placement of the server components in the network. The usability of the model is illustrated on examples.

Book

(5) Péter Kárpáti, *Designing and Scaling Proactive, Self-Organizing Video Servers . A Formal and a Simulation Model,* by Vdm Verlag Dr. Müller, April 2008
*Summary.* Nowadays video-on-demand servers must fulfil high expectations to attract and keep clients. New concepts and architectures are being developed to improve services and take full advantage of the available resources. One promising technique is offensive adaptation, which increases the availability of insufficient resources as needed. Such servers usually need to be proactive and have flexible, self-organizing architecture. This book describes how to develop VoD servers, scale them before installation and evaluate their performance. It analyses predictor functions and similarity measures to forecast client behaviour and to achieve proactivity. A formal model is presented which facilitates the planning and evaluation of VoD servers and supports their self-organizing behaviour. Experiences gained from previous concepts are combined in a simulation environment to assist in the design of such servers and their algorithms. Finally, the results of one large and two small-scale performance studies are presented, comprising a method for performance analysis as well. Video server developers, VoD system designers and other researchers in this field should benefit from reading this book.

## III -Attended Seminars, Workshops, and Conferences

- Visited an introductory course to healthcare informatics during the winter semester 2007/08.
- Participated in many shorter workshops and seminars at NTNU and NSEP (Norwegian EHR Research Centre). A bigger one was hold in Veiholmen, Norway between 31.10.2007 and 01.11.2007. I also held two seminars at NSEP:
  - o 07.11.2007: The coordinative aspect of communication in hospitals
  - o 06.02.2008: Communication support in health care (with Prof. Pieter Toussaint)
- Held seminars at ERCIM institutes during the "Exchange Programme" visits:
  - o 18.04.2008, Trinity College Dublin: Messaging as a means for clinical process support
  - o 30.05.2008, SICS's Mobile Life Center: Messaging as a means for clinical collaboration
- Presentation of papers (1) and (3) in the respective upcoming conferences.

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

The two institutes visited were:
- IUA Trinity College Dublin, Jane Grimson, 03.09.2007 - 02.09.2008, Dublin, Ireland
- SICS's Mobile Life Center, Kristina Höök, 03.09.2007 - 02.09.2008, Stockholm, Sweden
At both institutes, I have held seminars about the project in general and also specifically about my contributions to the project. I attended the seminars they offered during my visit and consulted many of the colleagues there to get deeper insights about their research involvements. Our conversations concerned both theory and practical know-how. I observed the practices and work methods of other institutes which strengthened my leadership abilities. I have made valuable professional contacts through these programs.