



# MINEMA

## Scientific Report of the Visit to the Mobile Systems Group of the Alpen-Adria-Universitat Klagenfurt

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*Abstract*

This document is a scientific report of my visit to the Mobile Systems Group of the Alpen-Adria-Universitat Klagenfurt, Austria. This project has been supported by the European Science Foundation (ESF) MiNEMA Scientific Programme, Grant no. 1053.

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## 1 Introduction

This document is a scientific report of my visit to the Mobile Systems Group of the Alpen-Adria-Universitat Klagenfurt, Austria, from 2nd to the 5th of May 2006. The visit was supported by the European Science Foundation (ESF) MiNEMA Scientific Programme, Grant no. 1053.

The purposes of the visit were:

- Preparation of a long-term (2-year) research exchange;
- Technical discussion with Ph.D. student Udo Schilcher and Prof. Bettstetter on network coding for wireless and mobile networks.

This report is organized as follows: in Section 2 we briefly describe the scientific motivation and the goals of the present visit; in Section 3 we describe the the work carried out during the visit; finally in Section 4 we draw the conclusions and describe the future steps for a research collaboration.

## 2 Field of Research and Goals of the Long-Term Project

State-of-the-art routing and topology control schemes for self-organizing wireless networks assume that the basic operations carried out at each device in a route is limited to storing, replicating, and forwarding data packets. However, recent results from network information theory indicate that improvements in throughput and robustness are possible by allowing these nodes to recombine several input packets into one or more output packets. This concept of combining different information flows in a network is called "network coding."

The goals of the long term project are to make significant contributions to both theory and practice of self-organization and topology control algorithms for wireless networks operating specifically under the new paradigm of network coding.

## 3 Description of the Work carried out during the Visit

In this visit I've met with the Mobile Systems Group members, namely Prof. Christian Bettstetter and Udo Schilcher. We had several research discussions concerning network coding in mobile wireless systems. In particular, I gave a presentation entitled "*Network Coding: Research Directions and Applications*", where I gave an overview of the network coding state-of-the-art, applications and open problems, and I've presented my intended research directions in the field of network coding.

Udo Schilcher also gave a presentation about his research work on network coding. He has emphasized the trade-offs in the use of linear/non-linear network codes, and the application of network coding for securing communications.

After the presentations we identified research issues concerning network coding, where we have common interests, namely:

- Energy efficiency;
- MAC and Network layer issues;
- Communication Security;
- Topological properties of graphs and network coding;
- Topology control for network coding in wireless mobile networks;
- Coding/Decoding strategies;
- Information Spreading with Network Coding.

Those topics were the subject of discussion during the rest of the visit. During these discussions we identified several open issues that need to be investigated and that we intend to address in our future research collaboration.

I also met with Anne Rao Koteswara from the Informatics in Transportation Group, and we had discussions concerning possible applications of network coding theory for the optimization of transportation processes in transportation networks.

I made a visited the labs of the Mobile Systems Group where I assisted to an OPNET Lab lecture given by Udo Schilcher, whose topic was network coding. Prof. Christian Bettstetter gave a Mobile and Wireless Systems II lecture at the University which I was also pleased to assist, becoming familiarized with the research and teaching facilities of the University of Klagenfurt.

## 4 Conclusions and Future Collaboration

This document has presented the report of my visit to Prof. Christian Bettstetter of the Alpen-Adria-Universitat Klagenfurt. The research discussion on network coding and mobile wireless networks were very fruitful, and led to the identification of common research interests that justify a future collaboration between my home University (University of Porto) and the host University.

We intend to start a long-term research exchange, in which I will be visiting the Mobile Systems Group of the Alpen-Adria-Universitat Klagenfurt.

## 5 Acknowledgments

I wish to thanks my hosts at the Alpen-Adria-Universitat Klagenfurt, namely Prof. Christian Bettstetter and Udo Schilcher for the wonderful visit.

I also would like to thank to the European Science Foundation (ESF) Minema Scientific Programme for the grant that made this visit possible.