Lorenzo Keller

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Research interests

My research focus is on wireless networks and in particular sensor networks. I'm interested in studying how to improve the performance, reliability, energy efficiency and security of such networks under resource constraints. My approach is to both use a theoretical and systems approach towards addressing these problems. I strongly believe in the potential of such a joint approach: developing a theoretical scheme and testing it in a practical system provides validation for the theoretical approach and allows through feedback from practical deployments to formulate and address interesting theoretical questions that can have significant impact in practice.

Education

2008 - present **Phd in Computer, Communication and Information Sciences**
Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland

Thesis: Coding applications for sensor networks
Advisor: Prof. Christina Fragouli

2005 - 2007 **MSc in Communication Systems (Specialization in Networking and Mobility)**
Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland (GPA: 5.79/6.00)

Thesis: Linear coding with feedback for broadcast communications
Advisor: Prof. Christina Fragouli

2002 - 2005 **BSc in Communication Systems**
Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland (GPA: 5.41/6.00)

Publications

Journal papers

[1] L. Keller, M. Jafari, K. Argyraki, C. Fragouli, and S. Diggavi, Joint identity-message coding for sensor networks, conditionally accepted in *IEEE JSAC on Wireless Sensor Networks*, to appear in 2010.

Conference papers

[1] L. Keller, M. Jafari Siavoshani, C. Fragouli, K. Argyraki, and S. Diggavi, Identity Aware Sensor Networks, in *Proc. IEEE INFOCOM*, 2009.

[2] M. Jafari Siavoshani, L. Keller, K. Argyraki, and C. Fragouli, Compressed network coding vectors, in *Proc. IEEE International Symposium on Information Theory (ISIT)*, 2009.

[3] E. Drinea, C. Fragouli, and L. Keller, Delay with network coding and feedback, in *Proc. IEEE International Symposium on Information Theory (ISIT)*, 2009.

[4] L. Keller, E. Drinea, and C. Fragouli, Online Broadcasting with Network Coding, in *Proc. Network Coding Workshop: Theory and Applications (NETCOD)*, 2008.

[5] L. Keller, P. Upadhyaya, and G. Candea, ConfErr: A Tool for Assessing Resilience to Human Configuration Errors, *in Proc. International Conference on Dependable Systems and Networks (DSN)*,

2008.

Book chapters

[1] C. Fragouli, K. Argyraki, L. Keller, Multipath Diversity and Robustness for Sensor Networks, in *Sensor Networks: Where Theory Meets Practice*, Springer Verlag, Berlin Heidelberg, 2009.

EPFL Technical reports

[1] L. Keller, E. Atsan, K. Argyraki, C. Fragouli, SenseCode: Network Coding for Reliable Sensor Networks, 2009, *ARNI-REPORT-2009-001*.

[2] L. Keller, A. El Fawal, MAC layer functions for SLEF, 2006, *LCA-STUDENT-2006-005*.

Preprints

[1] N. Karamchandani, L. Keller, C. Fragouli, Computation with subspaces, under submission

Other contributions

2009 **JTossim**
Open source GUI to TOSSIM simulator that allow researchers in sensor networks to design experiments and analyze results (http://sourceforge.net/projects/jtossim/)

2009 **Sensor network demos**
Demonstrations of a sensor network used to present research to high school students (presented on 22.10.2009, 3.11.2009 and 3.12.2009 to local, national and international students visiting EPFL)

2006 **Teacher Control Panel**
Open source Java application allowing teacher to control student computers and multicast his screen. More than 7000 downloads. (http://sourceforge.net/projects/teachercp/)

Work experience

2008 - present **Research assistant**
ARNI laboratory (Prof. Christina Fragouli), EPFL, Lausanne

2007 - 2008 **Research assistant**
DSLAB laboratory (Prof. George Candea), EPFL, Lausanne

Summer 2006 **Research intern**
LCA laboratory (Prof. Jean-Yves Le Boudec), EPFL, Lausanne

1998 - 2007 **IT Consultant for Schools and Real Estate/Trust Companies**
– Development of custom applications
– Design and deployment of IT infrastructure solutions

Service

Reviewer for ICC, ISIT, ISITA, Globecom, IEEE Communications Letters, IEEE Transactions on Information Theory, IEEE JSAC and Computer Communications.

Teaching experience

Fall 2009 Teaching assistant for “Circuits and Systems I”, 2nd year undergraduate course, EPFL

Spring 2009 Teaching assistant for “Graph Theory”, 3rd year undergraduate course, EPFL

Summer 2009 Co-supervised summer student A. Karaagac

Summer 2008 Co-supervised summer student A. Sebestyen-Pal

Fall 2007	Assistant for “Principles of Dependable Systems”, Master course, EPFL
Fall 2005	Student assistant for “Introduction to Information System”, 3rd year undergraduate course, EPFL
1997 – present	Consultant for middle/high schools for computer science related activities

Selected recent projects

Identity aware sensor networks

Several sensor network applications may require not only to collect the sensor measurements, but also know the identity of the sensor associated with each measurement. Often these networks contain a large number of sources while each measurement can be expressed with few bits. In such networks the bulk of the transmitted data is constituted by the identities of the sources. In this work we designed joint data-identity codes based on subspace coding that achieve better energy efficiency and we built a system on top of TinyOS to validate their performance in a realistic setting both using simulators and deploying the protocol on a testbed of 32 sensor nodes.

SenseCode: network coding for reliable sensor networks

Two main design parameters of sensor networks data collection protocols are reliability and energy efficiency. In this work we propose a practical network coding scheme that allows to achieve new points in the energy-reliability tradeoff. In particular we developed a scheme that allows to improve reliability of existing data collection protocols in the presence of node failures. We implemented this protocol on top of the state of the art collection protocol and we showed substantial performance gains using a sensor network simulator (TOSSIM) and deploying the protocol in a 32 nodes sensor network.

Linear coding for broadcasting

In this project we studied how to improve the performance of broadcasting using linear codes. We studied how to reduce delay and increase the rate of broadcasting by leveraging feedback from the receivers. We proved that finding the optimal strategy is an hard problem and we proposed some heuristic algorithms that give significant benefits compared to existing solutions.

ConfErr: A Tool for Assessing Resilience to Human Configuration Errors

Human configuration errors are one of the main sources of downtime in large computer system. In this work we built a tool that using human error models rooted in psychology and linguistics generates realistic configuration mistakes. This tool allowed us to find serious flaws in widely used software packages and allowed us to compare resilience of functionally equivalent systems.

Phd and MSc classes

Advanced computer networks and distributed systems, Applications of convex optimization, Cryptography and Security, Distributed Algorithms, Distributed information systems, Human computer interaction, Information theory and coding, Intelligent agents, Management of technology and entrepreneurship, Mobile networks, Models and methods for large scale random networks, Multimedia documents, Performance evaluation, Principles of dependable systems, Principles of wireless networks, Real-time systems, Signal processing for speech, audio and acoustics, TCP/IP networking

Programming skills

Developed large projects (> 10k lines) in Java (experience in ME and SE editions), Matlab, C, PHP, NesC and VB. Proficient in shell scripting (bash). Developed smaller projects in Python.

Language skills

Italian (mother tongue), English (fluent), French (fluent), German (basic skills)

Network administration skills

10 years experience with TCP/IP in small networks (~ 50 hosts): from data link layer to application layer. Two years experience with small sensor networks (~ 32 nodes).

Hobbies

Music; philosophy/history with a particular interest in understanding the roots of European culture and comparing it to other cultures