

# NEWSLETTER

APRIL 2006



Issued from the collaboration between NCCR-MICS and the Indian Institute of Science in Bangalore, the Common-Sense project develops a decision-support system to maximize the impact of irrigation on crop yield while minimizing the intake of water. Based on wireless networks, the technology could be used in all semi-arid areas (on the picture, an open well in India).

PAGES 2 AND 3

# A COMMON-SENSE APPROACH TO RURAL DEVELOPMENT

*To understand the rationale behind the Common-Sense project, one needs to go back in time to spring 2003. As MICS was widely acknowledged as a success story due to its academic contributions and global visibility in the scientific community, concrete applications were still lacking to back it.*

The challenge was to design and implement an application of self-organizing networks that would be socially relevant in the context of developing countries, as a tool for economical and social development.

One element was crucial: a partnership with an institution of the developing world, in order to stick to the reality and to make it easier to deploy and assess the system in its intended environment. India proved to be an ideal geographical choice: while experiencing a booming economy backed by the excellence of its higher educational system, this country still has two third of its population living in underdeveloped rural areas, and faces formidable challenges to fill the social gap between the poorest and the richest.

A partnership with the CEDT, a department of the Indian Institute of Science in Bangalore (IISc),

soon materialized with the help and expertise of its chairman, Prof. Jamadagni (see next page).

## WATER INTAKE REDUCED

Rapidly, a theme emerged: agriculture, and water management. A reliable decision-support system is a component of a deficit irrigation system that seeks to maximize the impact of irrigation on crop yield while minimizing the intake of water.

The Common-Sense project aims at providing such a decision-support tool. A wireless network of ground-sensors records periodically the state (salinity, humidity) of the soil, the temperature and the volume of precipitations.

In our model, sensors record data on a periodical basis and send them to a central processing unit, which uses simple statistical computations and correlates them with meteorological and ground-water data in order to assess the optimal cropping, irrigation and harvesting strategy.

The central processing unit can be linked to external meteorological servers to help in the decision process. The applications envisaged are: calibration and verification of existing prediction models and deficit irrigation management.

Such a project is especially challenging due to its multidisciplinary.

Once the sensor network becomes reliable, hydrology and agronomy should provide accurate prediction models. But even with precise predictions, the system will be useless if the end-users do not trust it, or do not understand how to use it. That is why the project gives a central role to social and cultural issues.

## RESULTS TO BE KNOWN SOON

Finally, a sustainable business model should be found, be it for use by scientists whose discoveries on crop and climate will benefit the farmers, or for the farmers themselves if they are to use the sensors in their own fields.

Early results from a deployment in a controlled area are encouraging. Conclusions issued from the first real-life deployment will be known by the end of 2006. Precise figures on the impact over yield will condition the evolution of the project, which will be carried through two more iterations until the end of 2007.

JACQUES PANCHARD

# SENSOR NETWORKS FOR THE INDIAN FARMER

*Chairman of the Centre for Electronics Design and Technology, at the Indian Institute of Science in Bangalore, Professor H. S. Jamadagni was visiting EPFL earlier this year. The opportunity to have him talk of Common-Sense, the project issued from the collaboration between NCCR-MICS and the Centre.*

for very meaningful application, reaching masses and developing countries”, says Prof. Jamadagni. At the same time in Switzerland, Prof. Jean-Pierre Hubaux, from EPFL, was wondering if information technology could be used to fulfill human needs rather than “market needs”. Both men and teams met and made their wish come true through a project: Common-Sense (see the previous article).

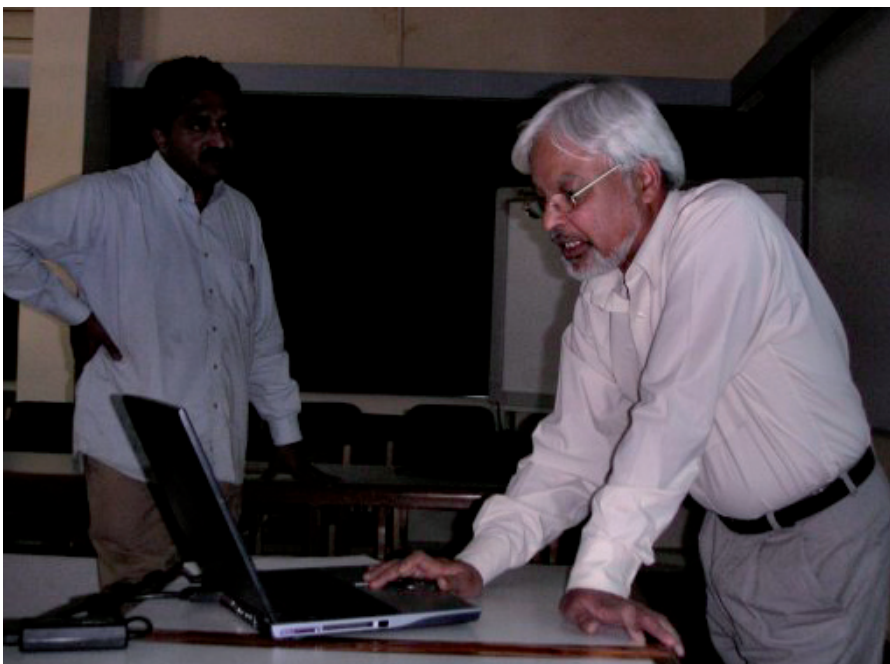
While NCCR-MICS researchers are

deployed outdoor on a 50 m<sup>2</sup> area. The tests will then be extended to a 100 m<sup>2</sup> field. “The purpose is to gather different kinds of data, from soil moisture, to light and depth of water”, explains Prof. Jamadagni. The Indian Institute of Science also collaborates with a rural NGO, Channa Keshava Trust, in order to match end-user needs.

For Prof. Jamadagni, this system is of particularly high interest since it could be applied to all semi-arid areas in the world. “The use of such devices requires neither a long training nor a difficult maintenance.” Furthermore, pest and disease control for crops could likely be integrated within the project, as well as a tele-veterinary system for remote diagnosis. Or, even wildlife monitoring.

But to make Common-Sense a widely used system would need to receive the Indian authorities’ support: “Only they could launch production lines that would therefore lower the costs. We are still far from such a move.”

FLORENCE LUY



“The Institute of Science in Bangalore has been working on sensor and ad hoc networks for a long time. Our idea was to use this technology

developing some of the devices, a large implementation team works in India. At the moment, a first prototype has been designed, built and

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# LOTHAR THIELE IN SEARCH OF THE UNIVERSAL PLATFORM

**Lothar Thiele, you are the current Deputy Director of the NCCR-MICS. what is your work within ETHZ?**

My research include models, methods and software tools for the design of embedded systems, embedded software and bioinspired optimization techniques. We are very much interested in randomized search algorithms for multi-objective optimization problems.

**What are your MICS projects?**

Currently, we are involved in three projects. One major effort is related to the prototype and development platform BTnodes. We are especially interested in models and methods that enable the deployment of large installations.

Another area we are working on is the design of reliable wireless sensor and actuator networks. The aim is to investigate composability in terms of hardware and software. We are interested in the analysis of distributed embedded systems in terms of essential resource properties such as energy, buffer space and timing. The project is done in cooperation with Tom Henzinger at EPFL.

Finally, we are involved in an application project that investigates sensor and actuator networks in buildings. In this project, several

colleagues from ETHZ are participating, namely Ludger Hovestadt, Manfred Morari and Thomas Gross.

**Where stand these projects now?**

The BTnode hardware and software is available commercially, the node



comes with basic software support and it is used in the practical exercises of the lecture on embedded systems at ETH, as well as by many research groups worldwide.

The second project has just started with new PhD students, so there is still much to expect.

**What are the main challenges encountered?**

There are many scientific challen-

ges within each of the projects I am involved in, especially in terms of understanding the design and the behavior of massively distributed embedded systems.

In addition, one has to be aware of the fact that there is not a single platform that is suited for all kind of sensor network applications. The different hardware/software systems are not easily comparable as each one optimizes for a certain application domain.

For MICS, this leads to the difficulty for everyone to choose the right platform for his experiments and to share his experience with other groups in order to optimize the learning curve.

- For more information, see also:
- <http://www.tik.ee.ethz.ch/~thiele>
- <http://www.btnode.ethz.ch>



*After a PhD in electrical engineering, Prof. Lothar Thiele worked for the Information Systems Laboratory at Stanford University and at the University of Saarland, in Saarbrücken. He joined ETH Zurich, as a full professor of computer engineering, in 1994, where he is leading the Computer Engineering and Networks Laboratory.*

# A NEED FOR COMPLETE END-TO-END SOLUTIONS

***The IBM Zurich Research Laboratory is one of the MICS Industrial Liaison Program members. Dr Pierre Chevillat, responsible for sensor network research in this laboratory, is also the chairman of the MICS Scientific Board. He explains the purpose of such a relationship.***

The IBM Zurich Research Laboratory (ZRL) works with various university labs and regularly publishes papers with them. Among others, it interacts with MICS academic community by being one of its industrial partners. The company regularly offers internships for students involved with the MICS Center. "They are given an opportunity to work on a relevant topic that will, at the same time, provide an added value to our projects. The students' work may involve algorithmic, protocol, or experimental research", says Pierre Chevillat. This partnership also implies strong links between IBM researchers and professors for exchanging their know-how.

IBM has eight research labs around the world. The Zurich Lab is the European branch of IBM Research. It focuses on three fields: systems, software & services, and science & technology. Research related to the

MICS area encompasses wireless technologies, hardware/software platforms for smart sensor units and gateways, and messaging middleware. It carries out performance evaluation with short-range wireless technologies that are highly relevant for sensor networking, such as IEEE 802.15.4 / ZigBee, Bluetooth, and IEEE 802.11. "We are also exploring the merits of wireless mesh networking to extend the range and enhance reliability. In addition, we are addressing the growing need for location-sensing functionality in wireless and sensor networks", explains Pierre Chevillat.

## CLOSE COLLABORATIONS

IBM's goal in this area is to provide complete end-to-end solutions ranging from sensors and actuators to business applications, such as integrating sensor networks with enterprise computer networks and the Internet. According to Pierre Chevillat, the research on mobile information and communication systems will particularly benefit from close collaborations between industry and universities. "This field has become so complex that it requires scientists from industry and academia to share their expertise."

In Zurich, researchers have built a wireless sensor network testbed to verify IBM's end-to-end concept

and evaluate its performance and scalability. Equally important, the testbed serves as a reference design and demo platform for various customer engagements. One of the main challenges today is the low power systems. Today's sensor devices and wireless communication elements still consume too much power – an obstacle that has to be overcome before we can expect the deployment of large sensor networks.

FLORENCE LUY

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## NEW PUBLICATIONS

### Journal papers:

- Patrick Vandewalle, Sabine Süsstrunk and Martin Vetterli, *A Frequency Domain Approach to Registration of Aliased Images with Application to Super-Resolution*, EURASIP Journal on Applied Signal Processing, Volume 2006, Article ID 71459, Pages 1-14.
- Razvan Cristescu, Baltasar Beferull-Lozano, Martin Vetterli and Roger Wattenhofer, *Network Correlated Data Gathering with Explicit Communication: NP-Completeness and Algorithms*, IEEE/ACM Transactions on Networking, Volume 14, Issue 1, February.
- Mario Cagalj, Srdjan Capkun and Jean-Pierre Hubaux, *Key agreement in peer-to-peer wireless networks*, Proceedings of the IEEE (Special Issue on Security and Cryptography), Vol 94, Iss 2, February.
- S. Capkun, J.-P. Hubaux, *Secure Positioning in Wireless Networks*, IEEE Journal on Selected Areas in Communications, Volume 24, Issue 2, February.

### Conference papers:

- Steffen P. Walz, *Serious Pervasive Game Design: First Steps towards a Spatial-Ludic Rhetoric for Sentient Architectures*. International Conference on computer games, advanced geometries and digital technologies, TU Delft, Mar 29-April 1st.
- F. Althaus, C. Steiner, and A. Wittneben, *UWB Geo-Regioning - Algorithm and Performance*, WPNC', Workshop on positioning navigation and communication, Hannover, Mar 16.
- J. Beutel, *Fast-Prototyping Using the BTnode Platform*. Design, Automation and Test in Europe (DATE 2006), Munich, Mar 6-10.
- Thomas Moscibroda, Stefan Schmid, and Roger Wattenhofer, *On the Topologies Formed by Selfish Peers*, 5th International Workshop on peer-to-peer systems (IPTPS), Santa Barbara, Feb 27-28.
- Michal Piorkowski, Matthias Grossglauser, *Constrained Tracking on a Road Network*, European Workshop on wireless sensor networks (EWSN), Zurich, Feb 13-15.
- Luca Negri, Lothar Thiele, *Power Management for Bluetooth Sensor Networks*, European Workshop on wireless sensor networks (EWSN),

Zurich, Feb 13-15.

- J. Beutel, M. Dyer and K. Martin, *Sensor Network Maintenance Toolkit*, European Workshop on wireless sensor networks (EWSN), Zurich, Feb 13-15.

### Demos in international events:

- Matthias Ringwald, Mustafa Yücel, Kay Römer, *Interactive In-Field Inspection of WSNs*, 3rd European Workshop on wireless sensor networks (EWSN), Zurich, Feb 13-15.
- Amre El-Hoiydi, Jean-Dominique Decotignie, *Low-Power Multihop Sensor Networking using WiseMAC*, European Workshop on wireless sensor networks (EWSN), Zurich, Feb 13-15.

## WORKSHOP ON SENSOR NETWORKS

In February 2006, the third European Workshop on wireless sensor networks (EWSN) was held at ETH Zurich. About 200 researchers from Europe and all over the world met to discuss the latest results and developments in this fast growing research area.

EWSN 2006 was a truly international event - of the 133 full paper submission received this year, about 40% originated from Europe, while 38% and 20% were received from Asia and the Americas, respectively.

### The technology becomes mature

Besides regular paper sessions, this year's EWSN featured a number of additional activities. Two tutorials were offered on data management and algorithmic aspects of sensor networks. Prof. Karl Aberer, director of the NCCR-MICS, delivered a keynote that covered, among others, recent achievements in MICS and the application potential of sensor networks in the Swiss context.

An exhibition with 30 technology

demonstrators and posters offered the opportunity to get in touch with the authors and developers directly.

A large number of sensor node platforms were demonstrated, illustrating the fact the sensor network technology is getting mature. Co-organized by the European Commission, a special session on European research projects related to sensor networks provided a good overview of the various activities in this domain in the 6th Framework Programme and the opportunities for research in the forthcoming 7th Framework Programme.

### Monitoring animal diseases

Finally, there was a special session related to the «Sentient Future Competition», which sets out to explore applications of sensor networks in a time frame of ten years. The contest was organized by Embedded Wisents - a Coordination Action in the 6th Framework Programme - and sponsored by Deutsche Telekom T-Labs.

Out of the 80 submissions received, the three best entries were selected by a committee of experts in the field. The winners were awarded and presented their ideas during the special session at EWSN. The winning submission explores the

use of sensor networks to detect and monitor the spreading of animal diseases - a very timely topic considering the current issues with the bird's flu. In addition, seven highly commended entries were presented by the authors during a poster session.

EWSN 2007 will be held at the Technical University of Delft in The Netherlands at the end of January 2007.

KAY ROEMER

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## UPCOMING CONFERENCES

International Conference on information processing in sensor networks (IPSN), Nashville, **April 19-21.**

25th Annual Conference on computer communications (Infocom), Barcelona, **April 23-29.**

4th International Conference on pervasive computing (Pervasive), Dublin, **May 7-10.**

7th International Conference on mobile data management (MDM), Nara, **May 9-12.**

**4th International Conference on wired/wireless internet communications (WWIC), Bern, May 10-12.**

See also program on <http://www.wwic2006.org/program.php>

6th International Workshop on innovative internet community systems (I2CS 2006), Neuchâtel, **June 26-28.**

2nd Workshop on cryptography for

ad hoc networks (WCAN'06), Venice, **July 16.**

3rd International Conference on mobile and ubiquitous systems: networks and services, San Jose, **July 17-21.**

International Workshop on self-organizing systems (IWSOS 2006), University of Passau, Germany, **September 18 - 20.**

Third annual IEEE Communications Society Conference on sensor, mesh and ad hoc communications and networks (SECON), Reston, **September 25-29.**

4th ACM Conference on embedded networked sensor systems, Boulder, **November 1-3.**

MICS Scientific Conference, **October 16-18.**

5th SNF site visit, **October 19-20.**

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## MICS CALENDAR

First MICS Industry Forum. Olympic Museum, Lausanne, **May 3.**

MICS Scientific Board meeting, **May 2-4.**

Summer school, **third week July.**

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