# WISEBED – Pan-European Wireless Sensor Network Testbeds

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## 1. INTRODUCTION

Until very recently, scientific efforts for studying computing methodologies for decentralized complex systems have been very limited. A particularly promising and hot research area is the design and analysis of *wireless sensor networks* (WSN, [1]), which has attracted researchers from very different backgrounds, such as hardware, software, algorithms, data structures and evaluation, as well as researchers from various other application areas.

The objective of a WSN is to monitor an environment at close range with high spatial and temporal resolutions. Examples of applications are monitoring and evaluating the health status of machines; environmental, medical, food-safety, and habitat monitoring; energy management, inventory control, building automation, etc.

So far, number and size of actual testbeds for sensor networks has been rather limited; a state-of-the-art overview of current and previous efforts is given further down. All of these efforts have been struggling with a number of different issues:

- **Hardware.** Developing small-scale devices that are capable of carrying out specific sensing activities, as well as storing and processing data that can also communicate via wireless radio interfaces, is a tedious, time-consuming and costly endeavor. Connecting them in order to build network structures needs new approaches due to resource constraints and the typical operation area (outdoors, remote).
- **Software.** Dealing with the limitations of small-scale special-purpose computing devices makes it very challenging to develop appropriate software, so far requiring custom-made software solutions.
- **Algorithms.** The classical theory and practice of algorithms focuses on a single central processing unit. Dealing with the challenges of designing algorithms for well-organized, large-scale distributed systems requires new algorithmic methods.
- **Data.** The large volume of collected sensing information, as well as the communication overhead gives rise to huge amounts of data. Storing, organizing, and evaluating this data in a useful and practical manner poses completely new challenges.

It is particularly striking that these aspects are strongly interconnected: e.g., shrinking hardware imposes new constraints and challenges on the design of software, algorithms, and data maintenance; increasing data traffic does the same for hardware, software and algorithms, etc.

When talking about Future Internet, WSNs are often among the major topics. Sensor networks are usually considered to be the extension of the Internet into the real world and will thus make up an important part of the Future Internet's architecture [2, 3]. The European project WISEBED which we are going to present in the next chapter, bas been selected, within the European FIRE strategy, to explore the possibilities of huge distributed sensor networks.

## 2. EUROPEAN PROJECT WISEBED

The aim of this project is to provide an infrastructure of interconnected testbeds of large-scale wireless sensor networks for research purposes. We intend to bring together different testbeds across Europe and form a federation of distributed test laboratories. We will provide services for allowing advances in theoretical computer systems to be tested, at least as a proof-of-concept, in large-scale environments, so as to assess the feasibility of the new concepts and verify their large-scale effects. We will engage on implementing recent theoretical results on algorithms, mechanisms and protocols and transform them into software that is independent from current technologies. Furthermore, we will evaluate code independence by using the different hardware available across WISEBED and place the resulting code under the scrutiny of large-scale simulations and experiments. This evaluation will provide valuable feedback and derive further require-

ments, orientations and inputs for the long-term research. In particular, we plan to do the following.

- We will deploy large numbers of wireless sensor devices of different hardware technologies in different types of terrains to use for evaluating and testing solutions at large scale.
- We will operate the testbeds to collect traces of data from the physical environment and derive models of real-life situations and scenarios. These scenarios will be used to evaluate the performance of algorithms and systems and draw conclusions on their operation and how it can be improved.
- We will interconnect these wireless networks with the Internet and provide a virtual unifying laboratory to enable testing and benchmarking, in a controlled way, in different "real-life" situations. Researchers will be able to use the facilities remotely, thus reducing the need for a local, private testbeds and, more importantly, reducing the cost for conducting all-rounded research.
- We will convert existing theoretical solutions into software and provide a repository of algorithms, mechanisms and protocols that can be directly used in future experiments as reference for benchmarking purposes. Such mechanisms will be tailored to small devices implementations of proxy and scaled-down solutions.
- We will use the repository of algorithms and develop a library WISELIB that can be directly used in future systems or integrated in order to deal with the vital challenges of the wireless sensor networks and offer efficient interconnection with the Internet.

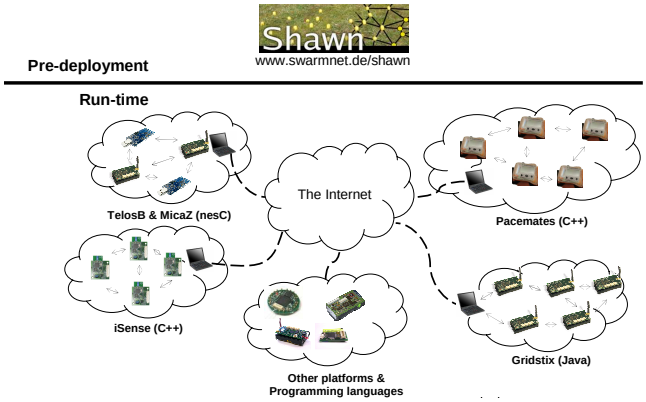


**Figure 1: Architecture of WISEBED**

We expect that our involvement in the above activities will lead to the development of a collective understanding on how to conduct research on wireless sensor networks and the Internet. Starting out from concrete applications, it includes all aspects of appropriate modeling, algorithm design, the implementation of robust and efficient software, algorithm analysis and evaluation by experiments. All these elements have equal importance, and our focus is to get a deeper understanding of the gap that exists between theory and practice and why it is hard to conduct all these steps in parallel and in continuous interaction. Our objective is to identify a broader methodology that proceeds in a cyclic development and improvement process between theory and practice. It will consist of design, analysis, implementation and experimental evaluation of practicable algorithms. Realistic models for computers and applications, as well as algorithm libraries and collections of real input data allow for a close coupling to applications.

Figure 1 presents the overall architecture of the WISEBED testbed, along with a hint concerning the pre-deployment phase. Developing sensor networks and applications will be strongly simulation-driven, and for that purpose, we employ Shawn [4], a specific sensor network simulator.

## 3. PARTNERS

WISEBED started in June 2008 as part of the FIRE initiative of the European union (`http://www.future-internet.eu`). It's overall volume will be in the area of 3.6 million Euro, with EU funding of 2.77 million Euro. The following partners will participate:

- University of Lübeck, Germany (coordinator)
- Freie Universität Berlin, Germany
- Technische Universität Braunschweig, Germany
- Research Academic Computer Technology Institute, Greece
- Universitat Politecnica de Catalunya, Spain
- Universität Bern, Switzerland
- University of Geneva, Switzerland
- Delft University of Technology, The Netherlands
- Lancaster University, UK

More information on the project is available on `http://www.wisebed.eu/`. In the talk, we will present more technical detail on the work programme of WISEBED.

## 4. REFERENCES

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