An overview of two wireless sensor network testbed projects and their extension into the future

Geoff Coulson
Computing Department,
Lancaster University
Lancaster, UK
geoff@comp.lancs.ac.uk

I. INTRODUCTION

In this talk I will offer an overview of two existing FP7-funded Future Internet projects: WISEBED and SENSEI. These projects have made significant contributions to the vision of a Future Internet and are now combining to form the core of a new FP7 project, SmartSantander, which will produce a pan-European Internet of Things (IoT) testbed. WISEBED and SENSEI are highly complementary to each other: WISEBED offers a *systems level abstraction* over instances of wireless sensor and actuator systems (WSANs) and their constituent nodes, while SENSEI focuses on *application level abstractions* that integrate multiple WSAN instances and add semantic and contextual capabilities. Clearly, both of these elements are essential components of the comprehensive IoT testbed which SmartSantander aspires to be.

In the remainder of this brief paper I first provide an overview of WISEBED, then of SENSEI, and finally of SmartSantander.

II. WISEBED

WISEBED (Wireless Sensor Network Testbeds) is a STREP that addresses EU FP7-ITC Challenge 1 – “Pervasive and Trustworthy Network and service infrastructures” under the area “New Paradigms and Experimental Facilities”. It comprises 9 partners from 6 European countries and runs from June 2008 to May 2011.

The goal of WISEBED is to enable the testing of WSAN systems and applications at large scale with high flexibility. Its approach is to federate individual per-site WSAN testbeds, already present at the project partners’ sites, to enhance the heterogeneity and scalability available to testbed users.

The most important and fundamental element in the WISEBED approach is its notion of *virtual testbeds* (VTBs). These are ephemeral virtualised testbed instances that are specified and used by a single testbed user and multiplexed over the resource base of the WISEBED federation. The defining feature of a VTB is that it mixes physicality, emulation and simulation: each VTB can combine (portions of) physical testbeds with emulated and simulated testbed elements. Using the VTB abstraction, the following key elements of a WSAN testbed can be selectively virtualised: sensor input/ actuator output, sensor/actuator nodes, connectivity/topology, power and mobility. In all of these elements, the user can exploit physicality where needed (e.g. for real-world sensor input; real radio characteristics; real overheads), but can choose to employ emulation and/or simulation where physicality is unwanted or impossible—for example, to enable arbitrary connectivity patterns/ topologies; to reduce experiment execution time; to feed virtual inputs to real sensors; to explore WSAN lifetimes; or to explore mobility in a repeatable manner.

Two years into the project, each partner’s testbed is accessible via a standardised web-services interface for control/management, and we can uniformly manage physical testbeds and VTBs via an interactive GUI front end. We have XML dialects to describe both testbed structure and sensor data, a sophisticated component-based software development kit supporting a range of platforms, and a growing algorithms library that testbed users can call upon. The main remaining limitation in the implementation is that VTB setup is currently a manual process. In the future we plan to automate this process significantly using a GUI-based approach.

III. SENSEI

SENSEI" (Integrating the Physical with the Digital World) is an IP that also addresses FP7-ITC Challenge 1 – "Pervasive and Trustworthy Network and service infrastructures", but under the area "The Network of the Future". It comprises 19 partners and runs from January 2008 to December 2010.

The overall goal of SENSEI is to facilitate the integration of the physical and digital worlds. This is a wider-reaching vision than that of WISEBED. The assumption of the project is that in the near future interconnected sensors and actuators will be deployed everywhere—by individuals, companies and WSN operators. The goal is therefore to render this infrastructure accessible and manageable through a global framework of standardised interfaces, essentially providing an "open market" for digital interaction with the physical world. There is a much greater focus in SENSEI on application building than there is in WISEBED, which is primarily targeted at systems designers. Therefore, SENSEI offers a range of high-level application-oriented services such as resource directories and semantic annotation/querying services.

SENSEI's top-level system architecture comprises i) *resources*, which are standard wrappers for heterogeneous devices (e.g. sensors, actuators, processors, managers), which employ XML-based resource description and which may run on separate hosts to the physical device; ii) *support services*, which mainly comprise resource directories, a semantic query resolver, and an 'execution manager' that supports long term queries (e.g. "tell me when this car-park has a free space"); and iii) *community management services*, which comprise account and identity management, security and privacy etc.

The SENSEI approach has been prototyped in a number of areas including *mobile environment monitoring* (sensors fitted to buses/trams in Belgrade providing data that is used by multiple applications to inform transport operators and users about pollution, delays and road conditions), *smart places* (sensors/actuators fitted within an office building used to manage meeting rooms, assist visitors, conserve energy and enforce security policies), and *smart cities*, a legacy system capable of city-wide sensing/actuation integrated with SENSEI to realise new context-aware services.

IV. SMARTSANTANDER

SmartSantander is a new IP that also addresses EU FP7-ITC Challenge 1 – "Pervasive and Trustworthy Network and service infrastructures", this time under ICT Call 5, Objective ICT-2009.1.6: "Future Internet experimental facility and experimentally driven research". The project is due to start in September and to run for 3 years, although commencement awaits final contract formalities.

SmartSantander will develop a huge pan-European testbed (target of 20K IoT devices, 12K of which will be in Santander) for experimentation with IoT technologies, architectures, and applications. It will feature extensive real-life deployment in Santander, Spain, which offers a rich urban setting encompassing key societal interests such as transport, work places, public spaces, hospitals, universities, etc. The testbed is aimed at researchers, service providers and also end-users (i.e. members of the public)—a much wider focus that the preceding two projects. In this way it will provide a European innovation hub for IoT, and complement other FIRE facilities. It will also provide a means to assess the impact of the future IoT on network infrastructures—the real requirements of IoT/FI/IoS etc. systems in terms of capacity, resources and services are currently unknown due to insufficient deployment experience. And, finally, it will provide a means to assess the social acceptance of IoT technologies and services in a real-world environment.