Bring the lab to the cities: experiences from two Dutch Living Labs

Ingrid Mulder, Daan Velthausz, Patrick Strating, Henri ter Hofte

Telematica Instituut, P.O. Box 589, 7500 AN Enschede, The Netherlands

{Ingrid.Mulder, Daan.Velthausz, Patrick.Strating, Henri.terHofte} @telin.nl

Abstract. The Living Labs concept is emerging, and seems appropriate for in-situ research. In this article, experiences of two Dutch Living Labs named Freeband and Kenniswijk are presented and reflected upon to motivate the current debate on experience and applications research. From the Kenniswijk and Freeband initiatives we have gained the insight that combining both approaches into one intelligent large-scale real-life environment provides an unobtrusive high quality environment in which usage of (novel) application can be validated. Such a future Living Lab raises new challenges and asks for new methods of data collecting and data analysis.

Introduction

In order to enhance quality of life, intelligent environments are often designed to sense, mediate and act upon information sensed from a person acting in context. Designers of intelligent environments face design issues like: selecting which information that can be sensed from a person and his context should be conveyed or aggregated to other human users (using human intelligence to interpret that information), and selecting which context information is reliable enough such that it can be interpreted and acted upon by computers in intelligent environments. Simultaneously, researchers of such intelligent environments face issues like: how to evaluate an intelligent environment in everyday life? The Living Labs concept is emerging, and seems appropriate for in-situ research. And therefore, to study in particular the questions mentioned above. However, most Living Labs do not exploit the peculiarities of intelligent environments.

In this article the authors share their experiences gained in two large Dutch broadband initiatives: Freeband and Kenniswijk. Experiences and challenges to design intelligent environments are described to motivate the current debate on experience and application research.

The Living Lab Approach

As said before, the Living Lab concept seems appropriate for in-situ research. The Living Lab approach represents a research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real-life contexts. Currently, a wide variety of innovation environments for validating, testing, developing new ICT based services and products exit (see Kulkki et al. (2005) for an overview). The majority of these initiatives are about real-life environments and not about intelligence to facilitate and enhance experience research. For this paper, we focus on the Dutch situation, and consider different types of Living Lab initiatives in relation to intelligent environments. A common accepted manner to study future needs for intelligent consumer applications is the experimental lab approach, also referred to as the Home lab approach[1]. As depicted in Figure 1, the level of obtrusiveness and situatedness of such an experimental approach is not really sufficient to gain good insights in *real-life* situations of new future services and context aware applications. More unobtrusive in-situ methodologies, like the Living Lab approach, are preferred.

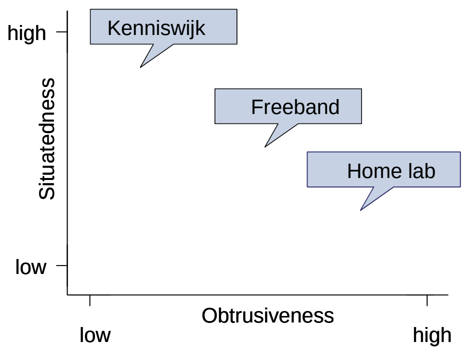

Figure 1. Dutch Living Lab initiative positioned in terms of obtrusiveness and situatedness.

First, two large Dutch Living Lab initiatives: Freeband and Kenniswijk are discussed. The Freeband initiative ranges from theoretical concepts to applications of this theory in practice. The Kenniswijk initiative enables an experimental environment and observes what happens: learning from experimentation. In the proposed paper, experiences are described and reflected upon to motivate the current debate on experience and application research. We elaborate upon the development of SocioXensor. This is a research tool that responds to the goal of doing in-situ research using the peculiarities of context-sensitive systems and capabilities of mobile and wearable devices. The aim is to provide the social sciences with a research instrument to gain a much more detailed and dynamic insight into social context, application usage, user experience and relations between these phenomena. In turn, these outcomes can inform the design of successful pervasive technology and context-sensitive applications. SocioXensor focuses on the collection of data in-situ, avoiding retrospective recall, which is encountered in other self-report techniques, such as surveys and interviews. For analyzing data collected from large-scale experiments (Living Labs), generic middleware services for reporting and analysis infrastructure are required to support social scientists appropriately.

Freeband

Freeband is a large Dutch research programme on ambient intelligent communication (85 million euro budget over 7 years), which comprises more than 30 organizations, including technology providers, knowledge institutes and many representative end-user organizations. The focus of Freeband is to pave the way towards fourth generation (4G) communication, i.e., 'seamless communication any time, everywhere and with the best possible means'. In the Freeband vision, the user is the center of information and communication, thus a user being in control of his information need and his communication means.

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[1] http://www.research.philips.com/technologies/misc/homelab/

The drive towards 4G comes mainly from two directions, one is the enormous increase of 'intelligent' and hence communicating devices in the direct environment of a user, including the devices in his own body area network (the 'ambient intelligence drive') and the other is the ubiquitous availability of the internet extending a person's presence and influence to the whole world (the 'internet dimension'). The Freeband approach should provide a significant improvement of our present means of communication, which still has limited possibilities, lack of flexibility and low bandwidth. The program is managed by the Telematica Instituut, which supports public-private research in the Netherlands. Freeband also works on a testbed infrastructure that strongly focuses on user experiences, and can be seen as a Dutch Living Lab initiative. Freeband addresses the entire knowledge chain of this new user-centric, ubiquitous communication paradigm. New knowledge is developed in the most important components of that chain, including communication infrastructures, service enablers and user applications.

The Freeband testbed provides testing, experimenting, validation, and an open playground for users, applications, middleware that support the goals regarding intelligent communication of Freeband. The emphasis lies on a user-centric research infrastructure to allow for research on applications and user experience to experiment with applications and to perform user trials in a near-life setting. Freeband enables support for (near) real-life validation and user experience measurement on Freeband services and/or products via sensing and logging of data from either a social context or hardware sensors, as e.g. generated by applications on mobile devices or by the underlying network. Freeband is especially active in the healthcare domain, researching and stimulating the use of the ambient communication paradigm to enable new applications and ways of working in healthcare practice, i.e., focusing on Cure (tele monitoring, tele treatment), Care (at home, tele care, integrated healthcare) and Well-being (preventive, we- and family-centric). For example, the teletreament initiative within Freeband investigates and demonstrates the feasibility of free health treatment concepts in real-life situations, meaning a treatment independent of time and place utilizing a mobile service infrastructure. Within Freeband novel concepts and applications in (near) real-life situations are validated[2].

The increasing number of mobile devices, sensors and consumer electronics that are equipped with all kinds of (wireless) networking capabilities, enable a complete new generation of context aware and pro-active applications. Applying this to area of experience and application research will be very beneficial. The insights gained within Freeband of developing, experimenting and validating novel concepts and application prototypes for real-life, in-situ sampling of user experience and context data, strengthen the need of larger scale unobtrusive real-life validation environments.

Kenniswijk

Kenniswijk is an initiative of the Dutch General Directorate of Telecommunication and Post (DGTP) of the Ministry of Economics. Kenniswijk is an experimental environment in the region of the city of Eindhoven where consumers have access to innovative products and services in the sphere of computers, (mobile) communication and Internet (early 2000 – October 2005). The intention is that the developments within the Kenniswijk-area are, on average, two years ahead of the rest of the Netherlands in 2005, resulting in a "consumer market of the future". Kenniswijk is a national project (45.4 Million Euro), which is carried out by a small, professional organization with a similar name Kenniswijk BV. In the

[2] See for an overview of results www.freeband.nl

Kenniswijk area live about 47,500 families (100,000 inhabitants), and there are more than 15,000 Fiber-to-the-Home connections. The inhabitants of the Kenniswijk Region Eindhoven form a good cross-section of the Dutch population with a relatively high percentage of Internet users. This area in the south of the Netherlands has excellent educational and research facilities and is the home of many innovative technology companies. An interesting observation is the chicken-egg problem between services and infrastructure; even in a project like Kenniswijk where services as well as infrastructures are funded it appears that broadband services are only developed when there is a broadband infrastructure available, and a broadband infrastructure is only initiated if there is explicit need to use it. However, after a slow and late start, the development of services as well as the fiber-to-the-home connections increases quickly. In total 116 project plans for innovative ideas were approved, and 15,430 fiber-to-the-home connections (of which 90% active) were installed.

Results show that there are interesting effects visible of the use of broadband Internet and its services. Sometimes, these effects are even visible within several months. The rich data not only shows invaluable and surprising insights in consumer experience, but also the active way of data collection contributes in a positive way to participants' awareness of how their behaviour has been changed and what they actually learned. In short, the Kenniswijk experiment is not only a valuable experiment to get insight in large-scale problems concerning infrastructure or the development of services. In particular, a lot of insights in customer behaviour have been gained. For all inhabitants of Kenniswijk the project remains a unique experience (Kenniswijk, 2005).

In sum, Freeband and Kenniswijk are large initiatives of the Dutch government. Without such experimental environments, achieving innovation [in the Netherlands] would be much harder. Such initiatives need to be stimulated in order to reach the ambition of Europe being the most competing and dynamic knowledge society of the world as defined by the European Council in Lissabon (2000). From the Kenniswijk and Freeband initiatives we have gained the insight that combining both approaches into one intelligent large-scale real-life environment provides an unobtrusive high quality environment in which usage of (novel) applications can be validated.

Discussion and Conclusions

The future of Living Labs can be envisioned as intelligent large-scale real-life environments. Intelligent environments allow for the design of new stimuli from which people can create their own meaningful experiences, which raise new challenges and ask for new methods and forms of interaction patterns between users and environments, and between different groups of users. SocioXensor is a research tool that responds to the goal of doing in-situ research using the peculiarities of context-sensitive systems and capabilities of mobile and wearable devices (Mulder et al., 2005; 2006). SocioXensor is an extensible toolkit that exploits the hardware sensors and software capabilities of contemporary mobile devices, such as PDAs and smartphones, to capture objective data about human behavior and social context (e.g., proximity, communication, application usage), together with sampling of subjective user experiences (e.g., needs, frustrations, and other feelings). The aim is to provide the social sciences with a research instrument to gain a much more detailed and dynamic insight into these phenomena and their relations. In turn, these outcomes can inform the design of successful pervasive technology and context-sensitive applications. SocioXensor focuses on the collection of data in-situ, avoiding retrospective recall, which is encountered in other self-report techniques, such as surveys and interviews. In the Freeband User Experience (FRUX) project, mobile devices are used as the primary data capturing devices, supported by sensors and beacons in other infrastructures, where this is possible and appropriate (e.g., in mobile testbed networks). More specifically, SocioXensor collects data at times and locations, which would be impractical or very costly with ethnography and lab studies, while maximizing the chance that subjects exhibit their natural behavior in their natural context. SocioXensor can be more obtrusive than logging, but it is typically less obtrusive than direct observation methods such as ethnography (which allow for very rich data capturing) or lab experiments or more details (see Figure 2).

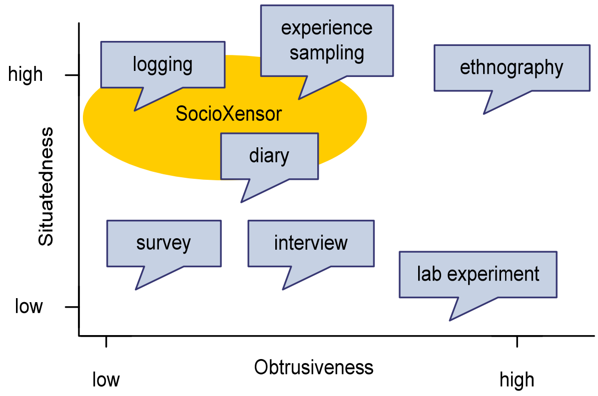

Figure 2. SocioXensor target area compared to other methods.

SocioXensor fits into an evolutionary prototyping research and design strategy, and can be used to get answers in field trials to formative and summative evaluation questions, such as:

- In which contexts do information and communication needs arise, and how often?
- What (combination) of contextual information is relevant for an application?
- In which contexts are application features actually used?
- What (combination of) contextual information predicts a user experience of an application?
- Did the user experience of an application improve? In which contexts?

The SocioXensor method guides researchers in their choices which questions to ask, according to which schedule to obtain user experience data, which human behavior and context data sensors to use, and which application usage data to log.

It is easy to envision that analyzing social context data, application usage data and user experience data collected in real-life settings will present new challenges. First of all, the amount of data produced in real-life measurements can be enormous. Amongst other things, this is due to the fact that it is not a-priori clear which data are relevant. These large amounts of data are needed to be analyzed and presented to interested parties, for example doctors in a healthcare telemonitoring scenario. This requires new analysis and reporting modules to support the researchers doing the real-life research. Also, because of the large amounts of data, it can be envisioned that storage and computing resources will be needed as supplied by grid infrastructures (Foster et al., 2002). Currently, many European and national research programs such as VL-E, CoreGrid, OntoGrid, NextGRID, try to use the possibilities of grid computing in more everyday life applications. These programs typically develop generic infrastructure components and computing functionality related to the standards of the Global Grid Forum (Kishimoto & Treadwell, 2005). This functionality also encompasses for example visualization or statistical analysis modules. The functionalities delivered by these projects provide big opportunities for Living Lab infrastructures, where large amounts of data need to be stored, retrieved, visualized and analyzed.

Particularly interesting for (future) Living Labs is the possibility of what could be called *ad-hoc computing*. In the case of real-life monitoring, it is conceivable that in the case of a sudden event, such as an epileptic seizure, large amounts of data need to be transported, analyzed and presented to a local professional with a mobile device in the direct vicinity of the patient (Broens et al., 2005). This poses new challenges for the technical infrastructure, since an end-to-end application/computation environment needs to be set-up quickly with device and context restrictions (is the medical professional on duty?) on the client side. In addition, the impact on the working process of the medical professional can be expected to be significant, because the ad-hoc medical decision process on the emergency treatment can be influenced by expert systems otherwise only available in lab environments.

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