Ambient Intelligence: Applications and Privacy Policies

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Abstract. In this paper, we present a complete overview of Ambient Intelligence (AmI) focused in its applications, considering the involved domain and technologies. The applications include AmI at home, care of elderly and people with disabilities, healthcare, education, business, public services, leisure and entertainment. The aim of this survey of AmI's applications is to show its socials and ethical implications and specially privacy issues. Intelligent Environments (IE) collect and process a massive amount of person-related and sensitive data. These data must ensure privacy of the users. An important concern in AmI´s applications is privacy. Addressing design by privacy, an important challenge to consider is the development of an architecture that includes the different privacy policies and how can we fusion them in a specific application domain. Ensuring privacy in Intelligent Environments is a difficult problem to solve, as there are different perceptions of privacy and its role in computing for each user. In the so called 'design by privacy' we have to identify the relevant design issues that should be addressed for its developing. Here we present an approach to the dimensions to consider, in order to provide privacy in the design of Ambient Intelligence's applications.

Keywords: Ambient Intelligence, Design Dimensions, Privacy-Policies, User's profile, Intelligent Environments.

1 Introduction

Ambient Intelligence (AmI) involves extensive and invisible integration of computer technologies in people´s everyday lives. Ambient Intelligence [1, 2] consists in the creation of living environments (called Intelligent Environments, IE) [3] where users interact in a natural and intuitive way with computational services which ease the completion of the user´s everyday tasks, being this for leisure, help or work assistance [4, 5]. Ambient Intelligence has potential applications in many areas of life, including home, office, transport, industry, entertainment, tourism, recommender systems, safety systems, healthcare and supported living. Ambient Intelligence will undoubtedly bring substantial economic and social benefits to citizens and industry, but they will come alloyed with many risks.

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Ambient Intelligence can be identified as an intelligent, embedded, digital environment that is sensitive and responsive to the presence of people [6], with five related key technology features: embedded, context aware, personalized, adaptive, and anticipatory [7]. The integration of computer technologies in AmI will inevitably open up issues of privacy, risks, acceptance and security. It has been widely acknowledged that is a need for acceptable standards and for laws regulating access, to avoid social and ethical problems [8].

This paper presents a survey of Ambient Intelligence applications focused in the involved domains and technologies. In order to provide a conceptual framework that includes the different privacy policies, privacy issues must be considered in the design in AmI´s applications. The design by privacy in AmI has to include several levels of privacy about how a specific Ambient Intelligence's application, acquires, stores, manages, shares and sends different types of personal dates. The different privacy policies depend on the next elements: ambient ubiquitous, devices, user, services, and legal requirements. Computer scientists who research in AmI must design Ambient Intelligence applications that achieve privacy by design jointly with legal experts.

The related work is organized as follows: Section 2 reviews some of the Ambient Intelligence applications considering the involved domain and technologies. In section 3 we show a study of privacy in AmI. In section 4 we show the design dimensions in the development of these applications in order to provide privacy with the aim to approach a framework for privacy enforcement, based in the domain of Ambient Intelligence and centered in the user. Section 5 presents our conclusions and proposes future work.

2 Ambient Intelligence Applications: A Survey

This section reviews some researches on Ambient Intelligence applications in several domains that include: home, care of elderly and people with disabilities, healthcare, education, business, public services, leisure and entertainment. The employed technologies include several devices as sensor, smart phones, tablet, NFC, RFID, etc.

- **Leisure and Entertainment / Commerce and Business**

The mobile interactions with the physical world are becoming available on the market, using mobile phones equipped with Near-Field Communication (NFC) [9]. The possibilities that NFC brings to users of mobile devices show a large variety in applications domains like shop, tourism and leisure. An important issue that must be considered is the user's interactions with NFC services. The authors of [10] showed potential of improvement and development for future NFC services that make it clear where interaction occurs, where feedback is given, and how the flow of interaction takes place. User problems in the interactions with this technology are strongly related to recognizing the availability of services, as interaction capabilities are often hidden.

A framework for a location based mobile Information and Communications Technology (ICT) system for the tourist industry is presented in [11]. This project is focused on content, information, products and services than can be offered tourists on a mobile platform, typically tablets or smartphones giving the users extra utility value. The solutions are interactive and based on the needs of the customers and the tourist