Is Ambient Intelligence doomed to fail? Design Guidelines for bridging the Digital Divide in the Ambient Intelligence Society

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The aim of this paper is to specify design guidelines for the sustainable development of Ambient Intelligence (AmI). AmI lies at the core of the European research policy for Information Society Technologies (IST) and seeks to empower individuals to improve their capability to participate in society. We want to address the issue of the digital divide in the emerging Ambient Intelligence Society. AmI is the next step in the development of information and communication technologies. It can be seen as the extension of the web into the physical world, adding intelligence, interactivity and connectivity to our everyday environments. In the visions of AmI it is often implied or even seen as inherent in this technology that it will bridge the digital divide and provide access for all in an inclusive AmI Society. Already existing technologies like Wireless LANs can be seen as the first step towards a wide diffusion of society with AmI technologies. This process shows that there is a possibility for the emergence of a digital divide even with the use of ambient technologies. Despite the ubiquity of WLAN coverage there is no access for all due to the prohibitive connection- and hardware costs and the lack of usability. The expansion of AmI technologies has the potential to even aggravate this situation, through barriers to entry, built up for example by registration fees or absence of computer literacy. Depending on how AmI is socially designed and applied it can foster inclusion or exclusion.

Keywords: Ambient Intelligence (Society), WLAN, Digital Divide, Design Guidelines, Participation.

1 INTRODUCTION

Ambient Intelligence (AmI) presents a paradigm shift in the way humans interact with computers. The current desktop computer gives way to ubiquitous technologies which are invisibly embedded in the environment of the user. Wireless local area networks (WLANs) are a first step towards the implementation of the AmI vision. However current access to WLANs is not equally distributed among the European citizens, a phenomenon termed as digital divide. The aim of this paper is to analyze the reasons for this development. We classify WLANS by organizational structure and economic model to gain insights how to prevent similar problems with future AmI technologies. Based on these findings we propose guidelines for bridging the digital divide in the emerging Ambient Intelligence Society.

2 BACKGROUND

In this chapter we present an overview about the core areas of this paper, Ambient Intelligence and the digital divide. We regard WLANs as a step towards AmI and discuss the dissemination of WLANs with a special emphasis on the digital divide.

2.1 Ambient Intelligence

Ambient Intelligence (AmI) is the pervasion of the everyday world with digital technology which is able to anticipate the user's needs and to support the user fulfilling these needs. AmI adapts to the requirements of the users and reacts to their presence. Another important feature of AmI is natural interaction, i.e. enabling the use of gestures, speech, gaze and movement to communicate with the system and with other users [13].

Weiser [16] has shaped the vision of Ubiquitous or Calm Computing, where computers are not bound to a fixed location but are unobtrusively integrated into the environment. The computer loses its predefined place as desktop computer and can be found in new contexts and application methods. The grey box on the desktop is replaced by a magnitude of connected embedded devices forming the foundation of AmI [8, 17].

The innovations generated in research centers, e.g. Philips HomeLab, Georgia Tech Aware Home, around the globe in the last years are slowly coming out of the lab and entering the daily lives of ordinary people. These circumstances lead to an increased economic relevance of Ambient Intelligence and technologies like Embedded Systems that are used to enable it. One could compare the current state of the Ambient Intelligence market with the market for cellular phones 15 years ago, including the potential for significant growth in the near future.

The vision of AmI is not just bound to indoor-areas but can be realized everywhere – also on public spaces. The sensible connection of the requirements which people have for their use of public places and the possibilities of new technologies is the foundation of possible application scenarios. AmI can be used as a social catalyst to encourage and foster social interaction between different users [6] or to persuade user groups to behave in a more sustainable way [14].

The widespread implementation of the AmI vision would have a tremendous impact on our everyday lives and society. Previous examples have shown that social and ethical regulation mechanisms have always lagged behind technological developments. It remains to be seen if the challenges to create a regulatory framework for an AmI society will be addressed early enough in order to "shape the envisaged systems according to fundamental social and ethical requirements" [1]. Punie [11] discusses the social implications of AmI focusing among others on the problem of the digital divide. He emphasizes the promise of AmI to bridge the digital divide through improved user-friendliness

2.2 Digital Divide and WLANs

In the 1990s the issue of the so-called digital divide was put on the agenda of political and public debate. The term describes the unequal access to new digital media, mainly to the Internet. Digital divide principally contains two major phenomena: one the one hand it means the gap between developed countries and developing countries and on the other hand the digital divide grasps the dissimilar access to information technologies within certain societies. In this paper we are focusing on the digital divide in Western societies where it has been stated: "Even in the most developed high-tech societies, where the division in physical access has stopped broadening, about one quarter, or even one third, of the population has no access to computers and the Internet." [15] This discussion is not limited to the material access, but also includes the necessary skills, which correspond partially with the usability of the technology.

Already existing technologies like Wireless LANs can be seen as the first step towards a wide diffusion of society with AmI technologies. WLANs present a novel way of connecting computers and other electronic devices to the Internet and also to each other. They are a first step in providing the user with connectivity and ubiquitous access to information. The ongoing diffusion of WLANs shows that there is a real possibility for the emergence of a digital divide even with the use of ambient technologies. Despite the ubiquity of Wireless LAN coverage there is no access for all due to the prohibitive connection- and hardware costs and the lack of usability.

In a typical scenario, a user who wants to connect to a WLAN in an urban area in Europe has the possibility to do so if seen from a technological perspective. Her computer or mobile device is most likely equipped with WLAN capabilities and the ubiquity of wireless hotspots which are mostly operated by mobile telephony access providers and other for profit companies in airports, train stations or other public spaces provide the necessary connectivity. When reviewing this scenario, access does not pose a problem for an affluent user who owns the device needed to connect and is able to afford the high connection fees. Users who don't meet all of these requirements currently face a barrier accessing WLAN services and are therefore excluded from the emerging information society. This is in sharp contrast to the EU policy as expressed in the *eEurope 2005 Action Plan* that aims towards "an information society for all" [2].

The problem of unequal access becomes aggravated by certain cooperate interest that lobby to prevent the public sector from offering free WLAN access. For example in 2005 in the United States the telecommunications companies Verizon Communications complicated the efforts of the city of Philadelphia to set up a public WLAN by lobbying for a law that gave companies the right to veto against municipal network plans. [4] This development was in clear contrast to the explicit goal of the city to bridge the digital divide by offering free WLAN access.

In Europe the major telecommunication providers such as T-Mobile or Vodafone primarily control the WLAN access points. Contrary to that, new grassroots initiatives towards free public access emerge: Users connect their personal WLANs based on pico peering agreements [10] to free local networks, e.g. DjurslandS.net or Consume.net. In accordance with Nicholas Negroponte's most accurate formulation this means "[…] a broadband telecommunications system, built by the people, for the people" [9]. Projects like FON [3] want to set up Europe-wide public access points. In this way they are extending the concept of (local) free WLANs to a larger scale and thus enable user mobility. Although this seems to be step into the right direction commercialization tendencies concerning FON become obvious: Google and Skype joined FON and became strategic partners and furthermore FON just has started additionally a paid service. This example shows that such grassroots endeavors to bridge the digital divide break down as soon as they are commercialized.

3 RESULTS

3.1 WLAN Classification

Based on an analysis of the existing WLAN infrastructure, we argue that these networks can be classified based on their organizational structure, as well as on the underlying economic model. Concerning the organizational structure we identified two different approaches: on the one hand WLANs are organized according to a top-down approach, which implies central control (e.g. corporations, public entities, universities) and little or no user participation. On the other hand lies the bottom-up approach that manifests itself in user control, participation, and self-organization and is driven by civil society communities. This approach can be seen in the grassroots tradition of social movements.

Regarding the underlying economic model we propose that there are three categories, social profit, "hidden" profit and profit. Social profit means WLANs that are freely accessible for the public without any constraints or economic motives. In contrast, profit oriented providers such as telecom operators offer access as a paid service. The "hidden" profit category can be located in the middle of this field of tension. Superficially it looks remarkably similar to the social profit model but they often work like a Trojan horse for the users. They lure them in only to bombard them with advertisements, to profile their behavior and collect personal data. Additionally often only the inferior service is free whereas the higher bandwidth access is only offered on a pay per usage basis, e.g. the Google WiFi service in San Francisco [7].

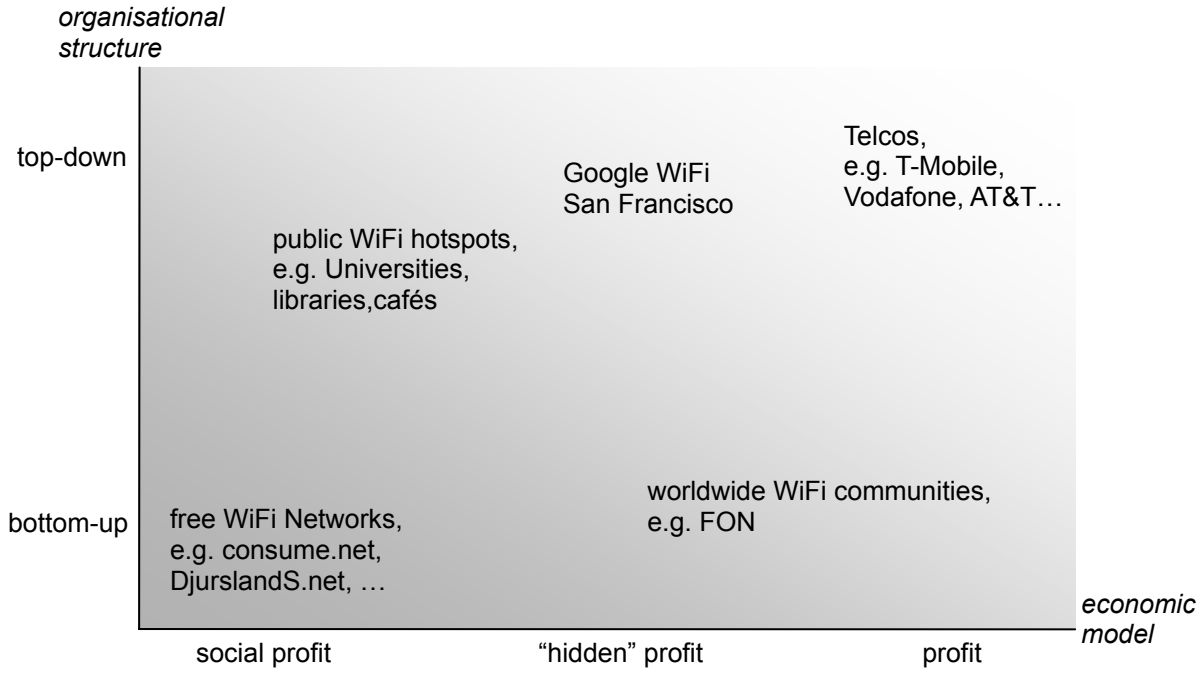

Fig. 1. Classification of WLANs: the vertical axis describes the organizational structure and the horizontal axis shows the economic model

3.2 Exclusion vs. Inclusion: Scenarios for AmI

Seeing WLAN as a first step towards AmI we demonstrated that the digital divide was not yet bridged with this new technology and equal access for everyone still remains to be a problem. The expansion of AmI technologies has the potential to even aggravate this situation, through barriers to entry, built up for example by registration fees or absence of computer literacy. Notwithstanding the superficial pervasiveness of AmI the implementation of such barriers is feasible, e.g. by limiting access through individual identification with RFID (Radio Frequency Identification) or biometric technologies. As the core idea of AmI is the ubiquity of technology that can be accessed by anyone anytime anywhere it could seem that AmI inherently helps bridging the digital divide. We argue that this is not necessarily the case since the possibilities for user identification mentioned above can be used to charge individual users for AmI services and exclude those who are not willing or cannot afford to pay.

On the contrary AmI could enable wider access based on more natural interaction techniques for human-computer interaction and computer supported collaboration than previous computer technologies

through the use of e.g. speech and gesture recognition. Such natural interaction should be based on lightweight interaction techniques so that users can proceed in small, experimental steps with immediate system feedback. Furthermore AmI inherits direct haptic manipulation by grabbing, moving and feeling objects and thus includes a quality perceived in the interaction with the real world. Finally AmI exploits spatiality as interaction parameter: the location of users or the manipulation of real objects can be processed by the system to anticipate the users' needs [5]. Such technologies can substantially build the basis for a real chance to bridge the gap between the information rich and poor through lowering the information literacy access barrier through increased usability.

4 DISCUSSION: IMPLICATIONS FOR DESIGN

Starting from an analysis of the WLAN-technology as a first real world occurrence of an AmI like technology we discussed in this paper two different AmI-design approaches: one the one hand we stressed a top-down approach where AmI technologies are centrally developed by corporations or public entities and on the other hand we described a bottom-up approach where AmI technologies are coordinated by grassroots initiatives and participative user control. We also highlighted that natural interaction techniques have the potential to foster inclusion. Based on our findings we propose recommendations for the following areas:

- *Coordinating policy & industry:* Policy-makers are required to set up a framework of general regulations, which guarantees equal access to AmI-technologies for all citizens because AmI has far reaching consequences for all areas of life that go beyond previous technologies. Similar to water and electricity AmI should be treated as a public service, which implies it should be available to all, regardless of income. This does not only correspond with the European Union's aim of an inclusive Information Society for all [2], but also offers opportunities for European companies to sell premium services to a large customer base. Providing free access does not mean preventing companies from offering advanced AmI services. Any such service that involves social interaction becomes increasingly more attractive due to the network effect, which states the value of the network exponentially grows with the number of users.
- *Supporting grassroots initiatives:* We suggest that the potential of such grassroots approaches should be utilized in the design and implementation of AmI. As we demonstrated with the grassroots example these initiatives are locally situated (e.g. particular neighborhoods) and don't reach a critical mass. As soon as those efforts become more widespread (e.g. FON) they tend to run the risk of commercialization. Due to these tendencies an increase in coverage does not necessarily mean an increase in inclusiveness and therefore doesn't bridge the digital divide. Yet the grassroots approach shows the willingness of certain users to participate in the implementation of WLAN technology if the means are readily available and sufficiently easy to use. This implies supporting these initiatives by providing them with user friendly "AmI toolkits". The idea of which is to provide users with building blocks "to configure and reconfigure interactive devices and services to meet local needs" [12]. In this way users are able to implement AmI technologies according to their personal needs and requirements and thus domesticate these technologies.
- *Designing natural interaction with AmI technologies:* In addition to user friendly AmI toolkits we challenge designers and researches in the field of human-computer interaction (HCI) to develop user friendly technologies that enable lightweight natural interaction to foster inclusion [11]. A prerequisite is to actively involve the users in the design process applying methods from participatory design. User participation helps the designers to meet the needs and requirements of the users. Additionally involving users helps to address user concerns regarding privacy, trust and security which would otherwise have a negative impact on the use of AmI. The goal from an HCI perspective is to provide the users with a new form of user experience.

5 CONCLUSION

Our classification of WLANs shows that equal access to such technologies is constricted by prevalent economic and organizational structure. Also current free grassroots approaches are either locally constrained or their expansions are accompanied by commercialization tendencies. This situation leads to unequal access of European citizens, a phenomenon known as the digital divide. Since WLANs present the first step towards

AmI there is the potential risk of similar developments in the emerging AmI society. To counter these tendencies we discuss issues that affect the AmI society: Policy-makers are required to set up general regulations enabling equal access to AmI for all. Also industry needs to adapt its strategies: On top of a basic free service the industry can provide paid premium services thereby profiting from a large potential customer base. Grassroots approaches can be involved in this process by providing them with affordable and user friendly toolkits. The design of future ambient technologies also poses challenges to the field of HCI to design natural interaction with AmI technologies.

Bridging the digital divide can only be achieved through a synthesis of bottom-up and top-down approaches. Policy-makers, telecommunication providers and researchers should act as enablers and set the framework for an AmI society by providing the technical infrastructure and user friendly technology for equal public access, creating the basis for user participation and grassroots design of AmI technologies.

Our vision is to encourage coordinated political, industrial and research efforts to provide the conditions for a sustainable development of an AmI society. In this society individuals are empowered by AmI technologies to improve their capability to participate in society and to optimize social well-being.

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