Ambient Intelligence in Public Services and Education

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Abstract. Ambient Intelligence (AmI) is a vision based on which the European Commission funds research activities in the field of information technologies. The vision aims at the seamless delivery of services and applications to the user in an intelligent, effective and transparent way that is easy to understand and use. The implications of the ambient intelligence vision demand for new software architectures and for the development of new hardware devices.
The public sector has the potential to develop a critical mass of first users for the AmI technology. By deploying AmI technologies in eGovernment, eHealth and eLearning substantial improvement in costs but also in quality can be introduced. But several challenges prevent the usage of AmI technologies in public services like the lethargy of public institutions to deploy new systems and the consolidation of public spending.

1 Introduction

Ambient intelligence is a vision created by the Information Society Technologies Advisory Group (ISTAG). The ISTAG counsels the European Commission in Information Technology funding. The vision of Ambient Technology shall give a guideline which projects and technologies are supposed to be sponsored in order to reach a common technology advance. Especially the funding of the European 5-7th Framework Programme for research and technological development is guided by the ambient intelligence vision.
The term "ambient intelligence" is not clearly defined as such, because "AmI is "a set of properties of an environment that we are in the process of Creating" [3]. ISTAG [1] refers to Ambient Intelligence as the "seamless delivery of services and applications" based on open software standards, user-friendliness and the convergence of network infrastructure. Other authors [6] [10] also describe the term "Ambient Intelligence" more closely. "Ambient Intelligence" characterizes a paradigm for the interaction between a person and his environment: the environment becomes aware of the human, his goals and needs and the environment provides multi modal interfaces to interact with it. [10] gives a psychological definition of Ambient Intelligence: "AmI is the effective and transparent support

to the activity of the subject/s through the use of information and communication technologies." In this paper we will apply the ambient intelligence vision in the field of public service in order to find systematically new applications and technology advances in these sectors. The ISTAG already pointed out that the public sector is a potential candidate to develop a critical mass for ambient technologies. We will give scenarios for ambient intelligence deployed in the public sector by the example of the education sector. We will also discuss advantages and critical factors in deploying new AmI technologies in public institutions. The paper is structured as follows: In section 2 we will present implications of the AmI vision and features of an AmI environment. In section 3 the hardware and software advancements that the AmI vision pushes forward are described. In section 4 we transfer the Ami vision to the public sector on the example of the education sector. In section 5 we will discuss critical factors that may prevent the deployment of AmI technologies in the public sector. In section 6 we will draw conclusions and give an outlook of future work.

2 Implication of Ambient Intelligence Vision

The definition of ambient intelligence is hold very broad in order to leave room for visions and technology advances in various directions. The implications of ambient intelligence and their feature are presented in the following. Later the required key technologies for developing such an environment will be described.

Embedded	Interconnected ambient intelligence devices are invisibly embedded in everyday objects such as furniture, clothes, vehicles. This not only means that ambient technologies are ubiquitously deployed but also that there will be interfaces for all objects.
Usability	User are able to naturally interact with the environment based on intelligent user interfaces. This means that users do not need to learn how to use and interact with the AmI infrastructure.
Context aware	A context aware environment is able to sense and understand the current situation and provides services to the user accordingly. Especially location based services is a broad application of context-awareness where services are provided according to the current or previous location of a user.
Personalized	The intelligent environment has to be aware of the users profile, his recorded data and needs in order to offer personalized interaction and data.
Adaptive	The environment and the offered services can be changed in response to a persons mood or health status, but also adapt to current social, ethical or political developments.

3 AmI Key Technology Enablers

In order to be able to approach the ambient intelligence vision a lot of technologies, not only in information and telecommunication but supporting technologies like smart materials, energy storage and miniaturization needs to be developed. We divide different technology fields into hardware and software based research.

3.1 Ambient Hardware Infrastructure

Ambient intelligence demands for sophisticated systems that enable the interaction with the user. The hardware for these systems are required to be deployed in an unobtrusive but ubiquitous way, with intelligent input and output interfaces for the user. Further the ambient system are able to sense the surroundings in a dynamic way. We pinpoint technologies that are required for an ambient infrastructure in the following.

Ubiquitous Communication Cheap connection enabling devices that provide the access to relevant data and services can be a WLAN infrastructure, GSM or UMTS network or anything beyond 3G.

Sensors Ultra low power sensors that have mutimodal interfaces work in the background of an ambient environment. Smart materials that not only react to human sensible changes can enrich the decision data for the ambient environment.

Interfaces Smart ambient interfaces that provide natural usability and interaction with the user. Technologies like head up displays, wallpaper foils, haptic and force feedback devices can improve the interaction by means of quality and effectiveness.

Embedded Device Ambient devices are miniaturized and ubiquitously distributed. Because of the large distribution only a wireless connection is feasible. This demands for low power consumption devices that use efficient energy sources, i.e batteries that can be charged by light, temperature or radiation. Because immense amounts of data are handled there is a demand for small storage devices that can distribute ambient data in a flexible way.

Handheld devices Ambient intelligence not only pushes forward the vision that the user can communicate with the environment using his speech, gestures or eye movement but also single wireless handheld devices that are able to offer and use network services. Further these handhelds include position sensing technologies enable location based services.

3.2 Ambient Intelligent Software

Ambient intelligence requires new sophisticated software architectures that support large, complex, distributed and heterogeneous systems. The ISTAG group therefore favors standardized open source middleware technologies in order to provide vendor independent interoperability. Software paradigms that will pave the way to the ambient intelligence vision are shown in the following.

Service Oriented Architectures Service oriented architectures (SOA) are a basis for the development of ambient intelligent technologies. SOA is a software paradigm that provides services either to end-user applications or other services distributed in a network [9]. Middleware that uses SOA enables the assembly of highly flexible, sophisticated and distributed applications by loosely coupling application components from heterogeneous systems. There are several software engineering frameworks that imply the service oriented paradigm, starting from the Simple Object Access Protocol (SOAP), BPEL, SODAPOP.

Semantics and Ontologies In order to cope with heterogeneity of systems semantics and ontologies are required. Semantics and ontologies help to understand and describe the different environments and the context of the systems and services and provide a way to translate their characteristics into a machine readable language.

Grid Computing and Distributed Databases Ambient intelligent systems are complex, large scale and widely distributed. The Grid computing paradigm supports flexible, coherent, secure and coordinated resource sharing between distant devices. Together with the service oriented paradigm complex system can become autonomic, i.e self-configuring, self-healing, self-protective, and self-managed. Some frameworks for GRID computing have been presented in OGSA [7] DAEDALUS [8].

Web services Web services support the machine to machine interaction over a common network. The interfaces to the web services are provided in a machine readable format (the Web Service Description Language WSDL based on XML has become a standard format for this purpose). Other machines can discover the offered services and can use them by sending XML messages.

4 AmI in Public Services

Public services are services that are provided for the benefit of all people either directly by the government or by financing private provisioning. Public services are usually those that are considered so essential and fundamental for life that their provision should be guaranteed. The ISTAG group points at the public sector as a potential candidate for ambient technology because it can develop a critical mass of first adopters. There are various fields in the public sector in which ambient intelligence can be applied. By deploying AmI technologies in telecommunication, government, health care, education and transportation substantial improvement not only in costs but also in quality can be introduced. In the following we will transfer the ambient technology vision to the public sectors with examples of the field of education. This shows the power of the ambient technology vision and gives an outlook of future applications.

Ubiquitously and Embedded People will be a able to access information from wherever they are - over everyday objects. One is not bond to learning facilities and can learn whenever and wherever it is suitable in virtual classrooms. For example the user relevant data can be displayed on walls or

furniture wherever he is located. Ambient intelligent technologies can facilitate cooperation in learning groups by providing interconnection of sparse people, giving them a common virtual environment.

Intelligent User Interfaces Intelligent interfaces can provide new ways to communicate not only with machines but also with other people. Ambient intelligent technologies can enables new methods for people with disabilities to take part in the learning process or provide students with new learning experiences and easier access to information. For example in an augmented reality environment students can interact with a virtual person from another country asking him for the way to the next metro. Or virtual helpers in a library can aid to a relevant book.

Personalized With personalized education it is possible to develop the full potential of students. An educational file that crosslinks results and answers from different classes can uncover possible lacks of ability. In after school online teaching, the virtual teacher can work on these shortcomings. The preferred interface (speech, blackboard, book) of a student can be recognized and appreciated during the learning process.

Adaptive With the use of artificial intelligence it is possible to adapt learning to the users abilities. The student can be supported on their level and develop their full potential. For example virtual teachers one to one teachers can adopt the difficulty level and pace of their lecturing according to the students previous answered questions.

5 Critical factors in deploying AmI

There are several challenges - besides the technological aspects - that need to be considered when deploying Ambient intelligence infrastructure. We will divide these challenges in general challenges and challenges that are specific to the public sector.

General Challenges

There has been several publications that deal with general social, emotional and ethical challenges of ambient intelligence [4] [2] [5].

Social Acceptance One of the greatest challenges in AmI is the social acceptance of the AmI technology. The ambient intelligence vision can only be achieved by users that accept the technological changes, but there could a certain distrust in giving more and more responsibilities to electronic devices - in a way that people more and more get dependent on them.

Separation Another issue is the willingness of users to be always accessible by others. People do not always want to be online and available for communication - a separation of work and home should still be possible. Therefore the ambient environment requires a switch how it can be turned off.

Privacy and Security The main issue is privacy and security. Since services are personalized private user data about the users behavior, attitudes, and

preferences needs to be stored. Although these information needs to be ubiquitously accessible by multiple applications it has to guaranteed that user data cannot be used against the users will.

Challenges in deploying AmI in public services

Finance The ambient intelligence infrastructure not only in terms of hardware but also in software is expensive. Nowadays governments eagerly follow Debt consolidation plans that slow down their willingness to invest in future technologies when only a long term (as in the field of education) can be expected.

Change resistant Public institutions have a lethargy of deploying radical new technologies but favor the improvement and integration of existing infrastructure. The deployment of new technologies is therefore more complicated and usually involves lobby work in different institutions.

Maturity Usually only very mature technology is deployed in the public sector because the benefits and maintenance costs can be estimated.

Regulations Before installing new technologies the public institutions are required to a run a predefined bureaucratic process. There has to be public tenders and comparisons to alternative technologies before implementation.

6 Conclusion

Deploying AmI technologies in the educational sector can support the advancement of AmI technologies because young people are more open minded to technological changes. These first adopters can help to improve the ambient intelligent vision based on their experiences and drive ambient intelligence into society. Nevertheless, several critical factors such as social acceptance, privacy and financial aspects have to be addressed. Therefore, future activities include educational aspects (making future users familiar with the benefits and limitations of ambient intelligence technologies), as well as joint efforts with public administrations and technology providers aimed at providing cost-optimized solutions for educational institutions.

References

1. ISTAG advisory group. Orientations for wp2000 and beyond. Technical report, ISTAG, 1999. `ftp://ftp.cordis.europa.eu/pub/ist/docs/istag-99-final.pdf`.
2. ISTAG advisory group. Scenarios for ambient intelligence in 2010. Technical report, ISTAG, 1999. `ftp://ftp.cordis.europa.eu/pub/ist/docs/istagscenarios2010.pdf`.
3. ISTAG advisory group. Ambient intelligence: from vision to reality. Technical report, ISTAG, 2003.

4. Jrgen Bohn, Vlad Coroama, Marc Langheinrich, and Friedemann Mattern. Social, economic, and ethical implications of ambient intelligence and ubiquitous computing. http://www.vs.inf.ethz.ch/publ/papers/socialambient.pdf, 2004. institute for pervasive computing. Springer-Verlag, 2004.
5. Rebecca Ellis and Morgan Potter. The socio-economic dimensions of ambient intelligence. Online artical, available `http://www.eurescom.de/message/messagejun2004/The\_socio\_economic\_dimensions\_of\_Ambient\_Intelligence.asp`.
6. José L. Encarnação and Thomas Kirste. Ambient intelligence: Towards smart appliance ensembles. In *From Integrated Publication and Information Systems to Virtual Information and Knowledge Environments*, pages 261–270, 2005.
7. Ian Foster. The physiology of the grid: An open grid services architecture for distributed systems integration. 2002.
8. Peter Ibach, Vladimir Stantchev, and Christian Keller. Daedalus - a peer-to-peer shared memory system for ubiquitous computing. In *Euro-Par*, pages 961–970, 2006.
9. Michael Papazoglou, Paolo Traverso, and Schahram Dustdar. Service-oriented computing: State of the art and research challenges, November 2007.
10. Giuseppe Riva and Francesco Vatalaro, editors. *Ambient Intelligence*. IOS Press, 2001. `http://www.emergingcommunication.com/volume6.html`.