AMBIENT INTELLIGENCE AND INTELLIGENT ENVIRONMENTS FOR MANAGERS' WORK SUPPORT*

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Abstract

One of the most developed and evolving areas promising for the future, which is already recently a subject of intensive research, seems to be the area of ambient intelligence. We present some recent results and contemplations about how this area could be exploited also for creating intelligent environments capable of managerial work support. Besides some general discussion we present also some of our views on the privacy concept which seems to be especially delicate in relation to the intelligent environments concept. Some notes about possible positive social acceptance of this phenomenon are concluding this work.

Key-words: *intelligent environments, ambient intelligence, privacy issues*

1. Introduction

The recent Knowledge-based society should be enabled also by existence of such environments which are rich of knowledge and thus in a well defined sense supportive to people surrounded by the environment. Such environments (known also as smart spaces or intelligent environments) have been particularly studied in the scope of the area of ambient intelligence, mainly from the enabling technologies point of view.

Ambient intelligence approaches and technologies are more and more matured to be able of creating an environment that is intelligently helpful to users surrounded by such an environment. Besides a number of well known applications of this concept in various areas, like smart home environment, or smart support to elderly or handicapped people (Augusto and Shapiro, 2007), we may consider it also as being very suitable for intelligent workplaces development.

An intelligent workplace can be, among its other features, also helpful in managing knowledge which can be usefully needed by the users working in the workplace. Such knowledge can be used not only for solving various problems requiring some expert knowledge to be properly solved, but also for learning at the workplace when creating decisions or looking for solutions of difficult tasks. In this view we may consider the evolving approaches based on ambient intelligence technology as one of the recent ways towards increased productivity achieved via better utilization of knowledge.

* Paper presented at the Annual International Conference in Economics, Informatics and Communication Field, *Spiru Haret* University, Câmpulung Muscel, 21-22 May 2010.

In this paper, based on our recent research (Bureš and Čech, 2007a, b, c; Bureš and Čech, 2008; Mikulecký, 2007; Mikulecký and Olševičová, 2007), we wish to stress the possible role of such intelligent environments for managerial work support. Such environments inevitably need to be rich of knowledge; therefore, a synergy of approaches and techniques from ambient intelligence as well as from knowledge management is necessary. We present some views on what are the basic features of intelligent environments, what are the key problems related to individual privacy as well as other problems which could influence the social acceptance of the presented approach.

In our paper we advocate the concept of such an intelligent workplace, which can be helpful in overcoming some barriers and stressful situations typical for managerial decision making. Such a workplace should, among its other features:

- ensure broad but focused (and personalized) access to relevant information and knowledge resources, supporting thus both learning needs of the manager as well as creation of his/her decisions;
- offer as much relief from stress as possible by avoiding all the usual stressful situations (or more precisely their potential sources);
- ensure broad and up to date technical support for all main activities in the workplace.

2. Materials and methods

It is well known, that managers, in order to be able of producing the best possible strategic decisions, should have the right information in the right time. However, without having the appropriate knowledge, the production of good decisions would not be easy, if not impossible. It is, therefore, quite sensible to think about such a managerial workplace, where the manager would have the best possible working conditions in various meanings of this formulation. What are the most natural aspects of managerial work? First of all, a manager has to have an access to all the necessary information on which the best decision can be built. In order to ensure it, it is necessary to be aware of having as good information as it is possible, and moreover, this information must be supported by knowledge relevant to the application or exploitation of particular information. According to (Turban et al., 2006) management is a process by which organizational goals are achieved through the use of various resources. All managerial activities revolve around and are carried out through continuous decision making, and are very much knowledge based, or knowledge rich. The managerial decision making or support involves the following steps:

- Identifying and defining the problem (a decision situation: an opportunity or trouble).
- Classifying the problem into a standard category.
- Constructing an abstract model that describes the real-world problem.
- Finding potential alternative solutions to the modelled problem and evaluating them.
- Selecting and recommending a good enough and appropriate solution to the problem.

The nowadays decision making environment is changing very rapidly, because business and its environment are more complex today in the global market. The decision making function has become more complex for several reasons. First, the number of available alternatives is much larger today than ever before because of the improved technology and communications systems, especially the availability of the Internet and its search engines. Second, the cost of making errors can be very high because of the complexity and magnitude of operations, automation, and the chain reaction that an error can cause in many parts of the organization. Third, there are continuous changes in the fluctuating environment and more uncertainty in several impacting elements. Finally, decisions must be made quickly. Factors causing complexity of managerial decision making are mainly as follows (Turban et al., 2006):

- More alternatives of managerial decisions because of growth and advancement in ICT, as well as advancement and diversity in technology in general.
- Larger error cost because of increased competition, as well as increased structural complexity.
- More uncertainty because of increased consumerism, as well as decreased and fluctuating political stability.
- It is a need for quick responses because of decreased and fluctuating political stability, as well as growing, complicating and fluctuating market economy.

As a result of such complexity, managers must either become more sophisticated or must have the tools to overcome increased complexity. In our opinion, the later case is the promising direction that should be expected from the ambient intelligence (AmI) approach as a collection of sophisticated intelligent tools for managerial decision support. We do believe that the AmI principles can be considered as being very suitable for creating a really usable learning environment, as a part of more general intelligent environment for managerial support. Usage of the AmI principles is in this case concentrated not only on solving managers' profiling problem, but it is more complex, with a number of equally important issues (e.g. customization, context-based services, privacy issues, applications of AmI algorithms, intelligent interfaces, smart learning objects, etc.).

In one of our previous papers (Olševičová and Mikulecký, 2008), we have explored the possibility of introducing and evaluating different ambient intelligence sub-solutions and scenarios and experimenting with them inside particular web-based applications, so-called Learning Management Systems (LMS) that were developed to enable the way of education supported by advanced information and communication technologies, known as e-learning. This approach is in our recent research developed into a more general one, leading towards a more powerful environment capable not only to support and fulfil educational needs of managers (taking into account the original idea of smart spaces for learning), but also to support their work more generally and intelligently.

Roughly speaking, a smart space (or intelligent environment) is a region of the real world that is extensively equipped with sensors, actuators and computing components. In effect the smart space becomes a part of a larger information system: all actions within the space potentially affect the underlying computer applications, which may themselves affect the space through the actuators. Smart space technologies are evolving very rapidly, driven by factors including improvements in Internet access to the home, the increasing importance of teleworking and other Internet mediated business and entertainment activities, as well as the increasingly aging population.

An interesting technical solution represents e.g. the SmartOffice developed by INRIA (Gal et al., 2001). We share the belief that a computer should not require a new way of working; it should simply augment current working modes. So, computers should be invisible, not demanding user adaptation, while at the same time offering the benefits of data-processing power. For instance, in the SmartOffice, the user can work as in a normal (even computer-free) office. Intelligent environments are designed to facilitate computer use by making computers aware of humans and enabling voice and gesture commands. Another and a bit older direction towards smart spaces concept was described firstly by Abowd (1999) and others at the GATECH. They proposed the development of a unique experimental facility for the exploration of large-scale ubiquitous computing interfaces and applications that are aware of the context of their use and can capture salient memories of collaborative experiences. The proposed system provided several types of assistance for users: access to information, communication and collaboration support, capturing everyday experiences, environmental awareness, automatic receptionist and tour guide. The research by Abowd (1999) and other research directions use the name smart space mainly in the meaning of an “intelligent environment”. Usually the intention behind is to design and deploy an intelligent environment capable to communicate with the user surrounded by the environment, and to support him/her in fulfilling of some rather complicated activities.

3. **Results and discussion**

In our recent research project AmIMaDeS (Ambient Intelligence for Managerial Decision Support) we tried to analyze the nature of managerial work and reflecting the results of the analysis to improve managers’ workplace environment by designing and implementing at least some features of the ambient intelligence approach into the environment. Our goal has been oriented on creating such an intelligent environment that is capable to support managerial decision making as well as to fulfill managers’ educational needs, simultaneously trying to educate them by an unobtrusive and natural manner, in relation to the area where the core decisions are made. One of the practical goals of the project is to create a collection of sophisticated intelligent tools for managerial decision support (IMDSS – an intelligent managerial decision support space) based on the AmI approach.

These intelligent features are mainly oriented on an enhancement of the human contact with an IMDSS that consist of numerous variable activities and can be understood from the perspective of optional application of different AmI sub-solutions. Here we present some of the main areas of meaningful utilization of AmI principles and technologies in the developed architecture:

- user identification and logging;
- context-based services, customization, personalization and omnipresent monitoring;
- application of new programming principles and AmI algorithms;
- innovated hardware and new types of devices;
- intelligent interfaces, processing implicit inputs and interactions;
- support of communication inside the community;
- involving new types of smart learning objects;
- invisible file systems;
- affective computing;
- privacy issues;
- interaction of AmI subsystems.

Recently, the multi-agent approach based architecture is tested as the most appropriate for modelling the basic functionalities of the smart space designed. First experiences seem to be promising.

Let us devote some attention to the notion of privacy, because privacy and its content in an intelligent environment seem to be a very delicate as well as complicated problem. Some authors have already mentioned possible problems and risks in the area (see Bohn et al., 2005; Mikulecký et al., 2007). As a matter of fact, the main common objective against the AmI concept seems to be that it is possibly a basis for a very sophisticated and potentially dangerous surveillance system, in a sense a kind of a new "Big Brother". The personal privacy can be viewed from various standpoints, as Bohn et al. (2005) analyzed. Privacy is considered to be a fundamental requirement of any modern democracy. According to Lessig (1995) it is possible to distinguish among the following motives for the protection of privacy in today's standards:

- Privacy as Empowerment – privacy mainly as informational privacy, giving people the power of controlling the publication and dissemination of information about themselves. From the AmI point of view, especially the right to control the dissemination or exploitation of the information about a particular person, collected about him/her by the intelligent environment, could be endangered seriously. New legal norms in this direction are necessary.
- Privacy as Utility – the focus is on minimizing the amount of disturbance for the individual (no unsolicited emails or phone calls). Technologically it is feasible to tailor an intelligent environment so that it is not disturbing for the human surrounded by the environment. However, there could be a complicated task of tailoring the environment to be suitable for two, three, or more persons at the same time.

- Privacy as Dignity – this is not only about being free from unsubstantiated suspicion, but also about equilibrium of information available between two people. The balance (equilibrium) of information between a person and the surrounding intelligent environment could be a serious problem because of their conflicting aims: the environment in a sense "wishes to know" everything about the human in order to serve him efficiently, while for the human it is usually not necessary to be aware what the environment is about. The problem of unsubstantiated suspicion seems to be much more serious one, as the vast information about the concerned person will be collected somewhere in the common memory of the intelligent environment, which can be considered, from the previously mentioned point of view, to be a sophisticated surveillance system. New legal norms are here more than necessary.
- Privacy as Regulating Agent – privacy laws and moral norms can also be seen as a tool for keeping checks and balances on the powers of decision-making elite. In an intelligent environment it will certainly be easy to gather information of certain type enabling to limit or prevent the society from certain type of improper behaviour. On the other hand, there should be a subtle borderline between the information necessary for the social prevention and information potentially endangering the human right for privacy.

4. **Conclusion**

As Bohn et al. (2005) pointed out, the fundamental paradigm of ambient intelligence, namely the notion of disappearing computer (computers disappear from the user's consciousness and recede into the background), is sometimes seen as an attempt to have technology infiltrate everyday life unnoticed by the general public in order to circumvent any possible social resistance (Araya, 1995). However, the social acceptance of ambient intelligence will depend on various issues, sometimes almost philosophical ones. The most important issue seems to be our changing relationship with our environment.

We would not be surprised by a broad social acceptance of this new, recently developed phenomenon in a short horizon of a few years. According to Dryer et al. (1999) "our inevitable future is to become a machinelike collective society. How devices are used is not determined by their creators alone. Individuals influence how devices are used, and humans can be tenaciously social creatures." Actually, based on our experience, we cannot agree more, however, social consequences that ambient intelligence may have will certainly be addressed in a broad debate and a deep and focused research.

Our approach based on rather wide employment of ambient intelligence technology opens also a number of related ethical and privacy questions which must be solved simultaneously with introducing of the technology. We have to analyze the most important from a big variety of such questions. Nevertheless, we believe that the approach chosen will lead eventually to creation of a modern and supporting working environment especially suitable for organizational learning (on workplace) and knowing (ensuring an access to all the organizational knowledge

any time, when necessary). On the other hand, it promises also a number of interesting theoretical results.

Acknowledgements

The research has been partially supported by the Czech Scientific Foundation project No. 402/06/1325 AmIMaDeS as well as project No. 402/09/0662 DEMAPIAS.

REFERENCES

- Abowd, G.D., 1999. Classroom 2000: An Experiment with the Instrumentation of a Living Educational Environment. *IBM Systems Journal* 38, 508-530. Araya, A.A. 1995. Questioning Ubiquitous Computing. In: *Proc. of the 1995 ACM 23rd Ann. Conf. on Computer Science*. ACM Press.
- Augusto, J.C., Shapiro, D. (eds), 2007, *Advances in Ambient Intelligence*, IOS Press, Amsterdam. Bohn, J. et al. 2005. Social, Economic and Ethical Implications of Ambient Intelligence and Ubiquitous Computing. In: *Ambient Intelligence*, Springer-Verlag, pp. 5-29.
- Bureš, V., Čech, P. (2007a). Complexity of Ambient Intelligence in Managerial Work. In: *12th Annual Conference on Innovation and Technology in Computer Science Education*.
- Dundee, p. 325. Bureš, V., Čech, P. (2007b). Knowledge Intensity of Organizations in Knowledge Economy. In: *WEBIST 2007, Third International Conference on Web Information Systems and Technologies*. Barcelona, 2007, pp. 210-213.
- Bureš, V., Čech, P. (2007c), Recommendation of Web Resources for Academics: Architecture and Components. In: *WEBIST 2007, Third International Conference on Web Information Systems and Technologies.* Barcelona, pp. 437-440.
- Bureš, V., Čech, P. 2008. Ambient Intelligence and Support of its Development from an Educational Perspective, In: *International Congress on Pervasive Computing and Management*, New Delhi, India. Published by Sydney College of Management, Australia, p. 26 (1-9).
- Dryer, D.C., Eisbach, C., Ark, W.S. 1999. At what cost pervasive? A social computing view of mobile computing systems. *IBM Systems Journal*, 38 (4), pp. 652-676.
- Gal, C. L., Martin, J., Lux, A., Crowley, J.L. 2001. Smart Office: An Intelligent Interactive Environment, IEEE Intelligent Systems, 4. ISTAG 2001. *Scenarios for Ambient Intelligence in 2010*. Luxembourg, EC. Lessig, L. 1999. *Code and Other Laws of Cyberspace*. New York: Basic Books.
- Mikulecký, P. 2007. Ambient Intelligence and Smart Spaces for Managerial Work Support. In: *Proc. of the IE07 – The 3rd IET International Conference on Intelligent Environments*, The Institution of Engineering and Technology, London, 560-563.
- Mikulecký, P., Lišková, T., Čech, P., Bureš, V. (Eds.) 2009. *Ambient Intelligence Perspectives* (Selected Papers from the First International Ambient Intelligence Forum 2008), IOS Press, Amsterdam.
- Mikulecký, P., Olševičová, K. 2007. Smart Spaces for Intelligent Managerial Environments. In: *Proc. IADIS International Conference eLearning*, (Nunes, M.B., McPherson, M., eds.), Lisbon, Vol. II, IADIS Press, 117-120.

- Mikulecký, P., Olševičová, K., Ponce, D. 2007. Ambient Intelligence - Monitoring and Supervision of New Type. In: *Monitoring, Supervision and Information Technology (eds. P. Kleve, R.V. De Mulder, C. van Noortwijk), 2nd ed.*, LEFIS Series 1, Prensas Universitarias de Zaragoza, pp. 115-134.
- Olševičová, K., Mikulecký, P. 2008. Learning Management System as Ambient Intelligence Playground. *International Journal of Web Based Communities (IJWBC)*, 4 (3), pp. 348-358.
- Turban, E., Aronson, J.E., Liang, T.-P. 2006. *Decision Support Systems and Intelligent Systems, 7th ed.*, Prentice-Hall, Upper Saddle River, NJ.