Information Technologies in the Calm Technologies Era

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Abstract

Information and communication technologies met a culminant evolution even since they appeared, with major achievements that became established in various fields of activity. Currently, one can notice an increased tendency to upgrade from classic computers to other types of equipment, much smaller in size, able to perform similar functions, such as PDA's or mobile phones. Also, the expansion of wireless communication technologies allows the access to Internet and to users' permanent interconnection. Therefore, a normal desire of human beings is developed, that of using miniaturized equipment, with no less performance, capable to ensure access to various information sources and to support communication. This tendency will result in the transition towards a new evolution stage of the IT&C, known as the calm technologies era.

This study is intended to seize the main stages, characteristics and conditions that the technological evolution should pursuit and fulfil in order to ensure the success of calm technologies and, at the same time, to optimize users' economic and social life.

1. Introduction

Technological (r)evolution decisively marked the economic and social condition of mankind in all history stages, a phenomenon emphasized during the last decades especially by the achievements in the field of information and communication technologies. By *technology* we understand a practical scientific application to the purpose of achieving some objectives, especially commercial or industrial ones. [28] Currently, there is a hidden tendency towards miniaturising and the expansion of the use of technologies in all socio-professional fields and activities so as to reach the level of omnipresence and "invisibility" which would meet the object of being calm technologies.

The concept of *calm technologies* was first used by Mark Weiser from Xerox PARC in 1991 in the article entitled "*The computer for the 21st Century*" [1]. In 1995, Mark Weiser and Seely Brown worked together to elaborate the article "*Designing Calm Technology*" [2], on the same topic, which was then republished at the 50th anniversary from the appearance of computers, in 1977, under the name "*The Coming Age of Calm Technology*" [3], in the book called "*Beyond Calculation: The Next Fifty Years of Computing*". Subsequently, this concept was taken over and analysed by specialists in the field, especially as a consequence of the extended use of multimedia technologies and of the Internet, and is based on the idea that *computers should disappear into the „background" of our architectural space and easily switch between the centre and the periphery of our attention much like ambient displays.* [4] The idea promoted by Weiser was taken over and developed by many researchers, government agencies and companies. In this context, we can distinguish the European Community's Disappearing Computer initiative at the end of the 90's and the beginning of the 2000's, that funded a large number of research projects to investigate how the information technology could be diffused into everyday objects and settings and to see how this could lead to new ways of supporting and enhancing people's lives that went above and beyond what was possible using desktop machines. [5] Another definition of calm technologies presents them as having the purpose to reduce the "excitement" of information overload by letting the user select what information is at the centre of their attention and what information is peripheral. [6] These technologies must embed many small and highly specialized devices within our everyday environment in such a way that they operate seamlessly and become transparent to the person using them. [7] In order to meet the requirements, they must have three main characteristics: *to be everywhere, to be small and to be aware.* [7] "*The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.*" [1] But if we analyze the trends and developments of our day technologies – tiny, cheap processors with integrated sensors and wireless communications capability, attaching information to everyday objects, the remote identification of objects, the precise localization of objects, flexible displays based on polymers, and electronic paper – it becomes clear that the technological basis for a strange new world has been created: everyday objects that are in some respects "smart," and with which we can even communicate under certain circumstances. [21]

2. Stages of the IT Evolution

The evolution of computers met, in Weiser's vision, three major periods [2]:

1. *The mainframe era* characterized by the use of one computer by several persons that has to have a pretty high level of expertise in the field and in treating information resources (both hardware and software) as rare and expensive assets (Fig.1).

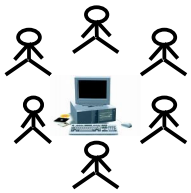
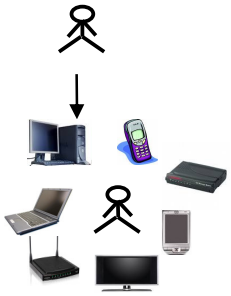


Fig. 1 The mainframe era

2. *The personal computer* era, including the Internet and distributed computing, where



almost every individual has his/her own computer. (Fig. 2).

Fig. 2 The personal computer era

3. *The ubiquitous computing era* is characterised by one person's access to a large number of computers placed in offices, walls, clothes, cars etc. Specialists [2] make, for this period, an analogy between the social impact of computers and that of other two technologies: *writing* and *electricity* which are so used and ubiquitous, that we cannot conceive everyday life without them (Fig. 3).

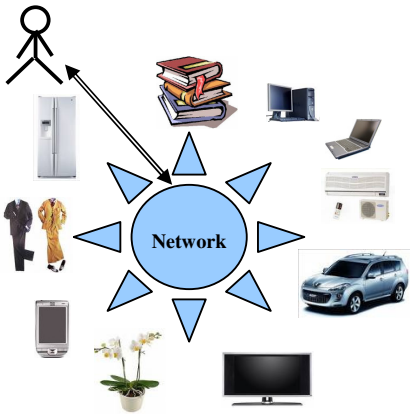


Fig. 3 The ubiquitous computer era

The last stage of the above-mentioned ones, specific to calm technologies, implies the easy transition from the periphery to the centre and back.

In a different approach made by Microsoft, the evolution of computers is divided in four stages according to the access of users to information and communication technologies, presented below [22]:

- 1960s: *Mainframe Era* – one computer per many users;
- 1980s: *Personal Computer Era* – one computer per user;
- 2000s: *Mobility Era* – several computers per user;
- 2020 and beyond: *Ubiquity Era* – Thousands of computers per user.

In this approach, researchers at Microsoft divide the last period in Weiser's vision into two stages, as a result of the major influences of mobile technologies and of the important achievements in the last decades in miniaturizing hardware components. Thus, they mark the transition to a more and more frequent use of laptops, mobile phones, PDA's, but also of the wireless communication equipment.

We believe that in the *Ubiquitous Era*, as delimited by Weiser, or in the *Mobility Era* and *Ubiquity Era*, as delimited by the researchers at Microsoft, as a result of the direct communication among computers, the *Transitive Interconnection* Era will emerge, consisting in fact in the following relationship: *several computers per several computers* (Fig. 4) During this era, the initiative for communication will belong mainly to computers and not to human beings, as it happened in the previous stages. Technologically speaking, this period is supported even starting from the current days, by information and communication technologies such as intelligent agents, hybrid technologies, the Internet, Extranet, Intranet, Robotics etc.

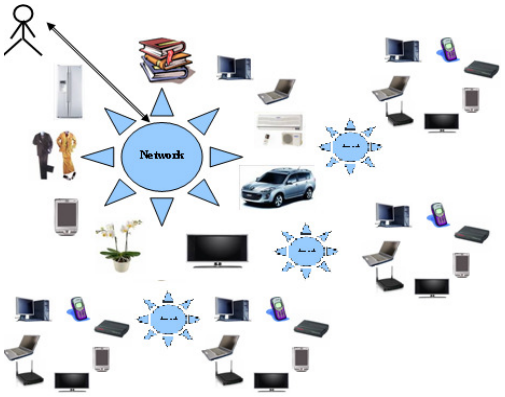


Fig. 4 Transitive Interconnection Era

3 The Main Characteristics of CT

The evolution of calm technologies was regarded by some researchers as a disappearance of computers considered from two points of view [12]:

1. *physical disappearance* – computers become small enough to be invisibly embedded in all kinds of devices;
2. *mental disappearance* – humans do not perceive the devices as computers but as embedded elements of augmented artefacts in the environment.

The main characteristics information and communication technologies should have in order to be considered calm technologies are the following [4]:

1. *calm technologies shift the focus of our attention to the periphery.* This technological orientation can be achieved either by smoothly and easily shifting from the center to the periphery and back, or by transferring more details to the periphery. An example is a video conference that, by comparison to a telephone conference, enables us to attune to nuances of body posture and facial expression that would otherwise be inaccessible.
2. *a technology is calm when it increases peripheral perceptions* with direct implications on our knowledge, which increases abilities to act adequately in various circumstances without being overburdened with information. Thus, the use of calm technology develops a pleasant environment.
3. *technological connectivity* enables a quick anchoring in certain circumstances against the background of a quick shifting from the center to the periphery of our attention, which determines a quick perception of the past, present and future of the subject. This characteristic leads to what Weiser and Brown call "locatedness".

Each of these characteristics are to be found, to a certain extent, in the technological achievements used nowadays, but, in order to reach the level of calm technologies, they must be fulfilled for each and every level and under all aspects by the objects in the surrounding environment.

The main purpose of this level of technological evolution is that the environment, the home, and our possessions be aware, adapt and respond to our varying comfort needs, individual moods and information requirements, for example, we would only have walk into a room, make a gesture or speak aloud and the environment would bend to our will and respond or react as deemed appropriate for that point in time. [5]

4 IT Concepts Similar to CT

The concept of *calm technologies* derives directly as a consequence of the global peace law specific to our universe [27], which, after the Big Bang, heads towards reaching an energetic equilibrium state that will possibly involve a new beginning …

In this context, humankind needs to be aware of the tendency of technological development, be it informational, not aggressive for the environment they will be used in. Therefore, in the field of information and communication technologies, the concept of *calm technologies* is strongly related to that of *ubiquitous computing*. The latter, also a Mark Weiser vision, represents the trend towards increasingly ubiquitous, connected computing devices in the environment, a trend being brought about by a convergence of advanced electronic - and particularly, wireless - technologies and the Internet. [10] Calm technologies represent more than ubiquitous computing, pursuing the incorporation of computing equipment into the environment more deeply, up to a level where it becomes invisible for the human beings.

Another concept that comes to support the development of calm technologies is the *context-aware computing* which focuses on detecting, identifying and locating people's movements, routines or actions with a view to using this information in order to provide relevant information that may augment or assist a person or several persons. [5]

Another notion belonging to the same category which is more and more spread, is *pervasive computing*, whose purpose is to deploy a wide variety of smart devices throughout our working and living spaces which coordinate with each other to provide users with universal and immediate access to information and support users in completing their tasks. The pervasive computing space has been mapped as a combination of mobile and stationary devices that draw on powerful services embedded in the network to achieve users' tasks. [13]

Another concept that contributes to the development of calm technologies is *ambient intelligence*. This metaphor tries to picture a vision of the future where all of us will be surrounded by intelligent electronic environments, and this ambient has claims to being sensitive and responsive to our needs. [14] Technical foundation of Ambient Intelligence is Ubiquitous respectively Pervasive Computing: the diffusion of information technology into all appliances and objects of the everyday life, based on miniaturized and low cost hardware. [15]

All these notions have, in fact, the same purpose*: to integrate the information and communication technologies into people's life in such a manner so as to be invisible, but ubiquitous.* The biggest difficulties in this approach are relate to data security, confidence, the need for specific settlements, because this concept implies memorising, processing and transmitting data regarding the activity of persons and they can allow the revelation of some confidential aspects of individuals personality and life. Despite all these possible reserves, the preoccupation in this field is quite extended, both in the academic environment and research laboratories, as well as in companies, with commercial purposes. From this last category we can distinguish the initiatives of IBM, which tries to change the image of e-business by using computers embedded in other devices in order to perform specific activities (pervasive computer), and Philips, which tries to create applications for an intelligent house with equipment able to collect and memorise its inhabitants' profiles and to adapt its behaviour to their preferences (ambient intelligence).

An important project, developed by Computer Science and Artificial Intelligence Laboratory in co-operation with The Acer Group, Delta Electronics, Hewlett-Packard, NTT, Nokia and Philips is the one called *Oxyen*, whose purpose is to perform the transition to the *human-centered computer*. According to this project, the characteristics information technologies must have are the following:

- *pervasive* - it must be everywhere, with every portal reaching into the same information base;
- *embedded* - it must live in our world, sensing and affecting it;
- *nomadic* - it must allow users and computations to move around freely, according to their needs;
- *adaptable* - it must provide flexibility and spontaneity, in response to changes in user requirements and operating conditions;
- *powerful*, yet efficient - it must free itself from constraints imposed by bounded hardware resources, addressing instead system constraints imposed by user demands and available power or communication bandwidth;
- *intentional* - it must enable people to name services and software objects by intent, for example, "the nearest printer," as opposed to by address;
- *eternal* - it must never shut down or reboot; components may come and go in response to demand, errors, and upgrades, but Oxygen as a whole must be available all the time.

Even if the most significant obstacles for calm technologies are considered to be at the social level, we cannot omit the physical ones, that is, the miniaturisation and the energetic autonomy of the devices used. The spectacular technological evolution of the last decades allows us to be optimistic and to foresee a solution for them in the near future.

Another problem that should be taken into consideration at the moment of the expansion of calm technologies worldwide is the addiction to technology, because the use of information and communication technologies in all aspects of someone's life could limit his/her independence. What would happen if a technologic blocking appeared due to various causes? As a matter of fact, we feel the addiction to technology at present when there is a power failure or when we have no connection to the Internet.

Another essential condition for the expansion of the calm technology concept is that hardware and software become accessible from a financial view point, so that every person or company can afford to buy them without making special efforts. Technological evolution, correlated with the evolution of prices in the last decades, can be a proof that this obstacle can be defeated. One example might be, in this respect, the evolution of laptops: the first laptop model with clamshell-type design (it shuts down by overlapping the screen and the keyboard), GRiD Compass 1101, created by Bill Moggridge from Great Britain and released in 1982, cost between 8.000$ and 10.000$. In addition, another significant example is the first commercial mobile phone, DynaTAC 8000X, created by Motorola and released on the market in 1983, which cost 3.995$. Currently, there are laptops that cost 100$ and mobile phones with prices between 10 and 20$. There is even a competition between the big producers for manufacturing the cheapest devices of this type.

5 Minimum Conditions for the IT to Become Calm Technologies

The development and implementation of calm Technologies requires the observance of some conditions even from their designing, which we present in the following lines.

1. *Adaptability*. Every person has his/her own characteristics and behaviour and, therefore, a universal model for all the people cannot be created. Calm technologies must be able to dynamically adapt their behaviour to the users' behaviour, learn their habits, schedule, recognize their activities and adapt their attitude according to this information. Moreover, users must accept the system, trust its decisions and actions and help it fix possible errors. Between human beings and technologies there must be both verbal communication and communication using gestures and actions, in order to allow the system to adapt to users' needs in a flexible manner. Also, all the information must be able to be stored and used according to particular situations.

2. *Information security and confidentiality*. Calm technologies involve storing some confidential information regarding the life, preferences and characteristics of people using them. For this reason, even since the designing stage, calm technologies must be projected in such a way so as to protect that specific information in order not to allow unauthorised users. Of particular importance, in this case, is the elaboration of a set of settlements in order to protect the user's interests, even if this cannot full guarantee the information security, but it only creates an optimum legal background for the implementation of the security systems and politics.

3. *Universal user interface*. Users of calm technologies have unconditioned and permanent access to various equipment able to meet their requirements. In order to efficiently use the facilities of such an environment, users mustn't feel the change from one place to another and they must be given the opportunity to interact easily and naturally with the surrounding objects irrespective of the place where they are: at home, at work or on holiday. Furthermore, the used objects must be able to interact among themselves in order to provide the user a maximum of comfort and support. An important role in this regard can be played by the wide-spread

development and implementation of the concept of Internet of Things, considered to be the next generation of the Internet applications, where surrounding objects can communicate, send and receive messages in a manner close to the way human beings behave.

4. *Invisibility*. Calm technologies should result in the substantial decrease of the direct intervention of human beings in the functioning and use of the objects from their environment, a characteristic that offers the objects a certain degree of invisibility. Thus, users might interfere in their functioning only rarely, if some dysfunctions might appear, which can be regarded as a process of continuous learning for the surrounding environment. In a world of calm technologies, users mustn't see the material system, but rather feel the results produced by it, correlated to their preferences and wishes.

5. *Integration*. Calm technologies imply the possibility of integration (IT&C) of all the equipment and applications used in a single platform, which is difficult to achieve if we consider their wider and wider diversity. An important function in this regard belongs to the hardware and software producers who must cooperate in order to create compatible applications and equipment, able to communicate among them. Moreover, a user may prefer a certain producer for certain equipment/objects and a different producer for others, and their simultaneous use shouldn't represent a problem, so as not to alter the user's personal comfort.

6. *Availability*. The implementation of the concept of calm technologies in real world determines a higher addiction to technology. In this regard, the possibility to permanently use the equipment and applications involved, in optimum conditions, without frequent failures or attacks, is essential. An important problem in this case is finding new energy resources, a topic that is more and more discussed nowadays, because, if all the objects are able to communicate among them and with the user as well, the current resources might quickly become insufficient or too polluting and would result in unimaginable disasters.

The observance of these conditions by all the developers of information technologies would implicitly lead to the emergence of the so-called *calmer Information Technologies and/of Communications (cIT&C).*

7 The c-IT&C Impact

Technological evolution has always had a significant impact on people's life, apart from the scepticism with which many innovations were regarded at first. The place taken by calm technologies, estimated to be even more favourable than the one occupied by information and communication technologies currently used, depends mainly on their capacity to prove their usefulness without invading the users' privacy, without nagging them and becoming a burden instead of being a support. At a social level, we consider that calm technologies will influence some essential aspects of life we are going to present in the following lines.

At an *economic* level, the changes can be important and favourable both by developing new products and by the way companies carry out their activities. In a future world of calm technologies it is necessary to make intelligent objects able to communicate among them, to perceive users' mood and needs in order to meet their requirements. In order to create them, new production lines are needed, raw materials and the materials they contain need to be changed, and the manufacturing technique itself must be modified as well. In this regard, we predict a change in the way competition is perceived, from *the best product to the most intelligent product* able to meet the consumer's requirements. These changes will allow a continuous economic development, which will be at least similar to the one we experience today. At the level of the performance of activities, the tendency is towards automating more and more of them. An essential benefit that calm technologies will bring is the increase in the work efficiency, including by transferring some activities to the objects in the surrounding environment. Here are some characteristics of the new economy in the context of the development of calm technologies:

- Development of new business models;
- Improvement of the quality of work;
- Improvement of the quality of products and services;
- Disappearance of some products and emergence of new ones;
- Increase in the function of research in the production-oriented companies;
- Evaluation of the companies' profitableness by also knowing the information wealth incorporated in the products and services provided to consumers;
- Development of new models of communication and cooperation among organizations.

The biggest changes should show clearly at a technological level, at least in a first stage. Regarding calm technologies, the following aspects are of high importance: the miniaturising of the components, the identification of new energy resources able to support continuous functioning of the equipment, and the development of wireless networks at a new level that allows communication among objects. Concepts such as personal computer, Internet, Personal Digital Assistant, Cell Phone will acquire new meanings, will increase and expand their functionalities in order to meet more explicit or implicit requirements coming from users. Information Society and Technology Advisory Group (ISTAG), in *Scenarios for Ambient Intelligence in 2010*, showed the main requirements that need to be met at a technologic level in order to be able to develop and expand ambient intelligence, requirements that are also true regarding calm technologies [20]:

- very unobtrusive hardware;
- a seamless mobile/fixed communications infrastructure;
- dynamic and massively distributed device networks;
- natural feeling human interfaces;
- dependability and security.

Private life (at a human level) caught the attention of calm technologies researchers. They intend to provide an improved life environment by transferring routine activities from users to the objects they interact with. Nevertheless, human beings represent the essential element in the evolution of calm technologies, since they are the ones who eventually decide upon, that is, accept or reject, a certain form of evolution. Obviously, from this point of view, there are disagreements between those who see the future world through calm technologies and the sceptics who consider either that these technologies cannot be made, or that they have more disadvantages than opportunities. While technological advances such as miniaturization, increasing computing power, and wireless connectivity open up the possibility of new applications, critics argue that it is not yet clear how these possibilities are actually going to be put into practice: we are "brilliant on means, but pretty hopeless when it comes to ends". [21] Calm technologies imply mutual adaptation of technologies and users. The surrounding environment must adapt to the implicit and explicit requirements of users, understand the context and users' intentions. As it is believed that more and more objects will incorporate technology, the degree of user addiction to the correct functioning of equipment and microcomputers, including the software, is continuously growing. We consider that these technologies will have an efficient function in the health sector: a continuous monitoring of the body's health and the transmission of signals when some deficiencies might appear could essentially improve people's life from this point of view.

It is worth mentioning that calm technologies will be gradually implemented in the social life and, as a consequence, the problem of accepting them becomes less critical. Obviously, there will always be some people reluctant to specific innovations, but the social evolution will establish a certain life standard that will make their acceptance necessary in various forms. Regarding the above-mentioned relationship, ISTAG names the following characteristics that are essential for the new technologies to be accepted by the society [20]:

- facilitate human contact;
- be orientated towards community and cultural enhancement;
- help to build knowledge and skills for work, better quality of work, citizenship and consumer choice;
- inspire trust and confidence;
- be consistent with long term sustainability both at personal, societal and environmental levels and long life leaning;
- be controllable by ordinary people.

8 Conclusions

Calm technologies, despite the fact that they are almost at the beginning, are believed to have not only a fulminatory evolution, but also a welcome one due to the benefits it provides. In this context, we consider that the future evolution of the information and communication technologies will establish the following changes determined by calm technologies [27]:

- Reduction/disappearance of the noise and the radiation caused by information technologies and communications;
- Lower power consumption;
- Total disappearance of the cables;
- Reduction of equipment size, while achieving higher performance;
- User-friendly and intelligent interfaces;
- Total interconnectivity and interoperability;
- Extension of the intelligent nature of information technologies and communications.

The evolution of calm technologies depends both on their capacity to be accepted by users, and to the producers' interest in this field. Given the present context, we consider that both categories will win if they are willing to follow this technologic tendency: the consumers, due to the decrease of the technologies "invasion" and due to the homogenisation of the way in which they are used, and, the producers, as a result of the growth in the demand for products with a variable degree of intelligence, but which incorporate equipment and software and which are able to communicate among them and with the users at the same time. In order to reach this level of evolution, technologic achievements must fulfil at least the above-mentioned conditions, that is, adaptability, integration, security, confidentiality of information, universal user interface, invisibility and availability. We must mention that, apart from the possible reticence from users, the development of calm technologies will mainly depend on their capacity to guarantee the security and confidentiality of information and, more important, it will depend on the discovery of new accessible and not polluting energy sources, that will ensure the long autonomy of most of the surrounding objects.

In order to check and validate the above-mentioned characteristics, it is necessary to establish a set of minimal standards for the development of calm technologies, whose achievement should be controlled at the moment of their implementation and during their use. Therefore, it is evident that the substantial efforts are needed for reaching the level of calm technologies, but we consider that the favourable social impact and the benefits they would provide will wholly compensate the financial and

human resources invested in their creation and will represent the next important stage in technological evolution.

References

[1] M., Weiser, *The Computer for the Twenty-First Century*, Scientific American, September 1991, pp. 94-104, Retrieved 15 June, 2008, from http://www.ubiq.com/hypertext/weiser/SciAmDraft3.html

[2] M. Weiser, J. S. Brown, *Designing Calm Technology, Xerox PARC*, PowerGrid Journal, vol. 1.01, December, 1995, Retrieved 10 June, 2008, from http://www.ubiq.com/hypertext/weiser/calmtech/calmtech.htm

[3] Denning, J.P., Metcalfe, M.R., *Beyond Calculation: The Next Fifty Years in Computing*, Springer-Verlag, New York, 1997

[4] A. Ţugui, *Calm Technologies in a Multimedia World*, Ubiquity, Vol. 5, No. 4, pp. 17-23, Retrieved 10 January, 2008, from http://www.acm.org/ubiquity/views/pf/v5i4_tugui.pdf

[5] Y. Rogers, *Moving on from Weiser's Vision of Calm Computing: Engaging UbiComp Experiences*, in P. Dourish, A. Friday (Eds.), Ubicomp 2006, Springer-Verlag, Berlin, 2006, pp. 404-421

[6] ***, Retrieved 2 May, 2008, from http://whatis.techtarget.com/definition/0,,sid9_ gci211737,00.html

[7] B. Hermans, *Desperately Seeking: Helping Hands and Human Touch*, Retrieved 14 May, 2008, from http://www.hermans.org/agents2/ch4_3.htm

[8] M. Weiser, *Some Computer Science Issues in Ubiquitous Computing*, Communications of the ACM, Vol. 36, No. 7, 1993, pp. 75-84

[9] P. Tandler, N. Streitz, T. Prante, Roomware. *Moving Towards Ubiquitous Computers*, IEEE Micro, Nov-Dec, 2002, pp. 36-47

[10] R. Kumar, R. Chatterjee, *Shaping Ubiquity for the Developing World*, International Telecommunications Union (ITU) Workshop on Ubiquitous Network Societies, Geneva, Switzerland, 6-8th April 2005

[11] Grillo, A., *Ubiquitous Computing*, Retrieved 11 June, 2008, from http://www.disi.unige.it/person/ReggioG/ISII01/Seminario%20UC.ppt#338,22,Scalability

[12] R. Grimm, J. Davis, B. Hendrickson, E. Lemar, A. MacBeth, S. Swanson, T. Anderson, B. Bershad, G. Borriello, S. Gribble, D. Wetherall, *Systems Directions for Pervasive Computing*, Retrieved 11 June, 2008, from http://www.cs.washington.edu/homes/tom/pubs/hotos01.pdf

[13] M. L. Dertouzos, *The future of computing*, Scientific American Magazine, Vol. 281, No. 1, 1999, pp. 52-55

[14] G. Riva, F. Vatalaro, M. Alcañiz (Eds.) *Ambient Intelligence: The Evolution of Technology, Communication and Cognition towards the Future of Human-Computer Interaction*, O C S L Press, 2005

[15] T. Kirste, *Ambient Intelligence: Towards Smart Appliance Ensembles*, Retrieved 10 May, 2008, from http://www.informatik.uni-rostock.de/mmis/paper.pdf

[16] A. Heikki, K. Aija, S. Esko, *Ubicom applications and technologies*, Retrieved 10 July, 2008, Retieved from http://www.vtt.fi/inf/pdf/tiedotteet/2003/T2201.pdf

[17] W. van de Velde, *Ambient Intelligence and Beyond*, European Commission DG Information Society and Media Future and Emerging Technologies, Retrieved 12 June, 2008, from http://www.iva.se/upload/Verksamhet/Projekt/Internetframsyn/U%20japan%20Van%20de%20Velde%20071122.pdf

[18] Federal Office for Information Security, *Pervasive Computing: Trends and Impacts*, SecuMedia Verlags-GmbH, Bonn, Germany, 2006, Retrieved 19 June, 2008, from http://www.bsi.bund.de/literat/studien/percenta/Percenta_eacc.pdf

[19] Computer Science and Artificial Intelligence Laboratory, *Pervasive Human-Centered Computing*, Retrieved 19 November, 2007, from http://oxygen.lcs.mit.edu/Overview.html#today

[20] K. Ducatel, M. Bogdanowicz, F. Scapolo, J. Leijten, J. C. Burgelma, *Scenarios for Ambient Intelligence in 2010* (ISTAG 2001 Final Report), IPTS, Seville, 2000.

[21] J. Bohn, V. Coroama, M. Langheinrich, F. Mattern, M. Rohs, *Social, Economic, and Ethical Implications of Ambient Intelligence and Ubiquitous Computing* in W. Weber, J. Rabaey, E. Aarts (Eds.), Ambient Intelligence, Springer, Berlin, Heidelberg, New York, Tokyo, 2005, pp. 5-29.

[22] R. Harper, T. Rodden, Y. Rogers, A. Sellen (Eds.), *Being Human: Human-Computer Interaction in the years 2020*, Microsoft Research, Ltd., England, 2008, Retrieved 20 August, 2008, from http://research.microsoft.com/hci2020/downloads/BeingHuman_A3.pdf

[23] M. S. Raisinghani, A. Benoit, J. Ding, M. Gomez, K. Gupta, V. Gusila, D. Power, O. Schmedding, *Ambient Intelligence: Changing Forms of Human-Computer Interaction and their Social Implications*, Journal of Digital Information, Vol. 5 No. 4, 2004, http://jodi.tamu.edu/Articles/v05/i04/Raisinghani/

[24] J. C. Augusto, P. McCullagh, *Ambient Intelligence: Concepts and Applications, Computer Science and Information Systems*, ComSIS Consortium, Vol. 4, No. 1, 2007, pp. 1-27

[25] Ž. Obrenović, D. Starčević, *Adapting the Unified Software Development Process for User Interface Development, Computer Science and Information Systems*, ComSIS Consortium, Vol. 3, No. 1, 2006, pp. 33-52

[26] L. M. Reeves, J. Lai, J. A. Larson, S. Oviatt, T. S. Balaji, S. Buisine, P. Collings, P. Cohen, B. Kraal, J. C. Martin, M. McTear, T. V. Raman, K. M. Stanney, H. Su, Q. Y. Wang, *Guidelines for multimodal user interface design*, Communications of the ACM – Special Issue on Multimodal Interfaces, Vol. 47, No. 1, pp. 57-59
[27] A. Tugui, *Calm Technologies as the Future Goal of Information Technologies*, in M. Pagani, Encyclopedia of Multimedia Technology and Networking, Information Science Reference, IGI Publishing, Vol. I. 2008, pp. 187-194