Problems and Prospects Towards Implementing Ubiquitous Computing

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Abstract

Ubiquitous Computing means network connectivity everywhere, linking devices and systems as tiny as a drawing pin and as large as a worldwide product distribution chain. This paper explores issues arising with implementing Ubiquitous computing, and gives examples of success stories where researchers leveraged Ubiquitous computing effectively. The paper further enumerates certain key issues and factors that affect the implementation of Ubiquitous computing, and finally provides insights towards how to seamlessly achieve the adoption of this new era approach to computing.

Keywords : *Ubiquitous Computing, Problems, problems*

Introduction

The idea behind Ubiquitous Computing is to surround humans with computers and software that are carefully tuned to offer them unobtrusive assistance as they navigate through their work and personal lives. Ubiquitous Computing according to the founder Mark Weiser is the third generation of computing. This generation will lead to an entirely new way of computing as compared to the previous two generations of computing. This generation of computing will see computers everywhere. That is, the computers will be with humans in their living space, and they would be interacting with the computing devices which will be unseen to their naked eyes. This is because, the devices will be embedded, so natural, so friendly, and so fitting to the extent that people would use them without even noticing.

Ubiquitous Computing aims to make human lives simpler through the use of tools that allow individuals to manage information easily. In essence, Ubiquitous Computing is a challenge that affects all Information Technology and Computer Science. The field of ubiquitous computing asks fundamental questions about how to put/implant computers everywhere and make them unseen? This challenge is drawing together researchers together from three (3) distinct perspectives which are:

i. **The Experience Perspective**: This perspective focuses on how people might share a world with Ubiquitous Computing environments. What interacting principle

underpins the human interaction with them, and how might a Ubiquitous Computing society be shaped from a socio-technical perspective?

ii. **The Engineering Perspective**: This focuses on the architectural and network challenges posed by the large scale, heterogeneous and dynamic nature of Ubiquitous Computing. What engineering principles are needed to allow a vast array of devices to be interconnected in a system and how might we understand and respond to the system's emergent behavior?

iii. **Theoretical Perspective**: This focuses on concepts and rigorous models that capture the behavior of Ubiquitous systems at varying levels of abstraction. How do humans reason about such a system in order to understand its aggregate behavior in terms of the behavior of its subsystems?

Collectively, these researchers constitute a response to a grand challenge whose goals are as follows:

a. To develop Ubiquitous Computing methods and techniques that is sensitive both to the needs of individuals and society, and the impact upon them. These will support the realization of human experiences and will include new forms of interaction and new interaction paradigms that make Ubiquitous Computing usable by all.
b. To define a set of system design principles that pertain to all aspects of ubiquitous Computing which are agreed among both academic and professional engineers, taught regularly in master's degree courses, and are instantiated in the design and rigorous documentation of several computational systems with a successful operational history.
c. To develop a coherent informatics science whose concepts, models, theories, and tools allow descriptive, explanatory, and predictive analysis of Ubiquitous Computing at many levels of abstraction. And also to employ these analysis to derive al its systems and software including languages, and justify all its constructions by these analytic tools.

The above are ideal goals, but there is no argument that place a limit on the extent to which they can be achieved. The grand challenge must be addressed by collaboration across the researchers' perspectives and usage guidelines together in an iterative manner.

The Previous Generations of Computing

Despite the fact that Ubiquitous Computing will lead to an entirely new way of computing, this paper thinks that there is need to understand the previous generations of computing.

The first era of computing is known as the Mainframe era of computing whereby many people use one computer. This computer was the central system from which entire offices and sometimes companies called their computing infrastructure. The mainframe computers are extremely expensive and very difficult to use for the average employee. Every computing task is done on the mainframe computer.

The second era of computing is known as PC – era whereby one computer is allocated to one person. This era saw an explosion in the area of information technology. That is, in this era computers became a mandatory device for use in business applications, and almost as commonplace as a television or telephone in today's homes. According to Weiser (1996), it is an era with person and machine staring uneasily at each other across the desktop.

Therefore, with the above previous generations of computing, one can understand that people interact with computers directly and physically. But Ubiquitous computing will advance the trend of computing devices to be more and more integrated into people's daily lives. According to Weiser

(1996), it will become the "Age of Calm Technology" as technology recedes into the background of human lives.

The Beginning of Ubiquitous Computing

Mark Weiser is considered as the father of Ubiquitous Computing. Weiser envisioned the third era of computing (Ubiquitous Computing) in 1985 when he was working at the XEROX Palo Alto Research Centre (PARC) as Chief Technologist. He describes Ubiquitous as follows:

> "For thirty years most interface design and most computer design has been headed down the path of the "dramatic" machine. Its highest ideal is to make a computer so exciting, so wonderful, and so interesting that we never want to be without it. A less-traveled path I call the "invisible", its highest ideal is to make a computer so embedded, so fitting, and so natural that we use it without even thinking about it".

According to the above descriptions, one understands that the idea behind Ubiquitous Computing is to make people interact with the computers in all their endeavors without even noticing the existence of the computing device. That is, computing devices will surround every aspects of human environment without necessarily being seen physically.

The research at the PARC headed by Weiser produced three types of wireless computing devices which serve as the first Ubiquitous Computing devices. These devices are affectionately named as tabs, pads, and boards.

Tabs were small handheld computing devices similar to today's palmtop computers. The PARC envisioned Tabs as the entry way for data in the Ubiquitous Computing era. It is useful enough to be used by everyone and small enough to be everywhere.

Pads were tablet sized laptop computers similar to today's tablet Pc's. It was designed to provide the freedom of portable and wireless tablet computers while still maintaining the power of a workstation. This task was accomplished by separating the computational engine from the display device, thus reducing the power to weight ratio (Ubiquitous Computing movies, 1995).

Boards are the yard-size displays that serve a number of purposes such as video screen, bulletin boards, and white boards or flip charts. A board might also serve as an electronic bookcase from which one might download texts to a pad or tab.

Therefore, when integrating the tabs and pads with the presentation – sized displays provided by the boards, the researchers at the XEROX PARC paved the way for the third era of computing which is known as Ubiquitous Computing. The paper will go ahead and point to some other examples where Ubiquitous Computing was leveraged positively.

Of recent, Ubiquitous learning was promoted by researchers who were examining the excellent attention and immersion which pupils can achieve while working on a computer; researchers are coming up with ubiquitous learning environments in which students engage in pedagogical activities. This area of research and case-studies has already yielded fruitful results such as the Research-based Educational Software called Cooties. "Cooties" is a virus-transfer simulation program designed for Pocket PC handheld computers; it supports socio-kinesthetic learning; i.e. incorporating social interaction with hands-on activity. Teachers determine variables such as incubation time of the simulated virus, individual immunity levels, and the number of initial carriers in the simulation. The program is appropriate for students from Grades 3 and up and can be used in science, anthropological, and mathematics.

Another success story is the Gaia project by Roy Campbell (2012): This researcher used Active Spaces to organize networked computer devices into a distributed system that cooperates and coordinates its activities with its mobile users. The researcher's work on Active Spaces examined how ubiquitous computing would support different physical human activities, from classroom and office activities to entertainment and communication. His Gaia project combined elements of HDTV, sensor networks, plasma touch panels, tracking cameras, mobile devices, speech recognition and synthesis, and location tracking into a rich tapestry. To enable location aware applications, he utilized various location sensing technologies including RFID, biometrics, Bluetooth, WiFi, and Ubisense. [Note: Ubisense represents a new class of UWB-based sensing devices that are economic to deploy in a building and have an accuracy of 6 inches 95% of the time]. The researcher reported that this ubiquitous arrangement when used in the classroom empowered students' and teachers' effective communication in a seamless fashion thereby encouraging larger number of students to participate actively even in large scale class settings.

Also, Emmanuel Agu of Worcester Polytechnic Institute (2012) discussed successes with ubiquitous computing in a healthcare setting, as exemplified with a Diabetics Self Aware tool which was successfully integrated with patients' Cell phone devices.

Key Factors Working Against Extensive Implementation of Ubiquitous Computing

i. **The Environment:** If one walks into an environment anywhere in the world, he/she would probably not find any structure suitable for Ubiquitous Computing devices. Instead, one would find an infrastructure suited towards established and well-grounded technologies such as electricity running through the walls, phone lines running into and out of buildings, and conveniences such as indoor plumbing. The individual is not likely to see newly constructed buildings equipped with devices to support Ubiquitous Computing.
ii. **Impromptu Interoperability**: Ubiquitous Computing as its name implies must have devices everywhere. But the problem now is that, who will make all these devices? It surely would not be left to a single company or manufacturer; it has to be a joint venture. Thus this presents one small problem. This is because, many technology-producing companies desire to produce their own proprietary products which will be structured to understand their own proprietary language which will eventually lead to non-interoperability between devices from different companies.
iii. **No System Administrator**: It should be noted that most individuals who operate personal computers have no intimate knowledge on how to administer a single workstation. It would be unrealistic for the manufacturers of Ubiquitous Computing devices to expect their users to administer a complex network consisting of multiple devices.
iv. **Social Implications of aware technologies**: Ubiquitous Computing will have a social impact on society just as the previous two eras of computing did. However, as these devices are constantly bombarded with input from their surroundings, the major effect now is the privacy of the society. That is, how will society turn to a social solution, legal solution, ethical solution, or technological solution to protect their privacy?
v. **Reliability**: Being devices everywhere and bombarded with different input from different angles, any failure in the devices or insecure of software will definitely affect the reliability of Ubiquitous Computing.
vi. **Presence of Ambiguity**: The role of Ubiquitous Computing must completely change the role of computing as offered by the personal computer. The personal computing era saw

the development and proliferation of desktop computers. The computer did what it was told to do. That is, if one punches a key on the keyboard or clicks the mouse, the computer processed the request, e.g. if a person requests the machine to send an email, it will automatically send it when he/she presses the send command button. But with Ubiquitous Computing where devices are everywhere and ready to accept input from any angle, all the devices would become nuisance with the bombarded input. The devices will be confused on what input belongs to which device.

Insights on How to Overcome the Above Factors/Challenges

i. Concerning the environmental factor, in order to support and implement the technologies of Ubiquitous computing, the environments of the users must be upgraded. Users should be able to realize the potential of these computing devices and gradually integrate them into their environments (Edwards and Grinter, 2001).
ii. For Ubiquitous Computing to be successful, the devices must have impromptu interoperability. That is, they should not just interoperate but should be able to interconnect and communicate with little or no advance planning. However, the Ubiquitous computing devices should be designed or written to understand the software of every other device.
iii. The "No system administrator" issue would be addressed through the idea of an already existing infrastructure known as telephone system. The telephone system is unique and possesses a "thin-client" alongside a robust and intelligent network. In this type of system, the telephone company services the network while the customer services the receiver. When users have an intention to use the telephone system, they simply pick up the receiver (thin client) and dial the appropriate number to access the network. As outlined by Edwards and Grinter (2001), to implement Ubiquitous computing successfully, there is need to provide solutions for remote administration, diagnostics, and upgrades to the existing telephone system.
iv. For Ubiquitous computing to be implemented, there is need to address the following questions as relate to the society. How will an individual know if they are within a "smart" environment where embedded devices are gathering data? Is it ethical to gather information from individuals without their knowledge? What information may be gathered? How may the information gathered be used, by whom, and under what circumstances? All these questions relate to individuals' privacy; they need to be answered before Ubiquitous computing can take real hold.
v. The Ubiquitous computing devices must be reliable. More so, the designers of today's computing devices (Ubiquitous devices) must analyze the design issues, interoperability issues, and perception issues that separate today's reliable and embedded technologies from today's unreliable personal computing devices.
vi. Because of the bombarded input to the Ubiquitous computing and also to avoid ambiguity, ubiquitous computing devices must be able to recognize changes in their environment, infer the action needed, and either complete the action or ask the user if they would like the action to be completed. The designers of these devices should make them very smart in accomplishing tasks, they should be able to make decisions on their own based on an event, they should have substantial model of the human world with which to make decisions.

Conclusion

The era of personal computing is coming to a close and the era of Ubiquitous computing is emerging. Both technologically advanced countries and developing economies are about entering a brave new world; a world where computers are everywhere, but rarely seen. Computing machinery will be embedded into devices hidden from view, while other computing will seem so natural that humans will use them without actually believing that they are computers. Ubiquitous computing era will create a new life style for human beings. It will be a life style where computers aid and assist humans in every of their daily lives. This new era of computing is fast moving from the realm of fiction to reality. This paper therefore calls and challenges software engineers and information systems analysts in developing countries like Nigeria to start reckoning with this phenomenon; It is also worth-noting, that this new era of Ubiquitous computing is bound to invade lives and bring discussions around individuals' privacy in the face of pervasive computing, even more to the forefront.

References

Edwards, K.W. & Grinter, R.E. (2001). At home with ubiquitous computing: Seven Challenges. From http://www.parc.com/csl/members/grinter/ubicomp.pdf

Hightower, j. & Borriello, G. (2001) Location systems for ubiquitous computing. IEEE Compute 57-66

ITU (2005). Ubiquitous Network Societies edition 2005. ITU

Roy Campbell: The Gaia project on Pervasive Computing. University of Newcastle upon Tyne. Accessed: 12/10/2012; http://gaia.cs.uiuc.edu/

Weiser, M. (1993). Ubiquitous computing. IEEE computer, p. 71-72

Weiser, M. & Brown, J. S. (1996). The Coming Age of Calm Technology. PowerGrid Journal, vol.1.01. Appear at http://www.ubiq.com/hypertext/weiser/calmtech/calmtech.htm