The CSFs and Services of Ubiquitous Computing

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ABSTRACT

Recently, the area of ubiquitous computing has gained a great attention both in academics and in industry. However, previous research on this area unsuccessfully attempts the categorization in part of context and the critical success factors (CSFs) and services of ubiquitous computing. The purpose of this paper is to propose a framework on ubiquitous computing: its context, roadmap, CSFs, and services.

Keywords: Ubiquitous Space, Roadmap, Service Implementation of Ubiquitous Space.

Ⅰ. Introduction

Recently, the new IT paradigm is appearing in the Ubiquitous computing area. The word, "Ubiquitous" which is frequently will be appearing in discussion medium, many people agree that the ubiquitous computing will change the domination of future information communication market and the new paradigm. However, most researchers mainly focus on the issues concerning the trend, forecast and technologies. The purpose of this paper is to propose a roadmap and the implementation of ubiquitous space.

II. Roadmap of Ubiquitous Computing

In order to construct a roadmap of ubiquitous computing, previous research and projects on ubiquitous computing are reviewed. TRON Project began in 1984 when Dr. Ken Sakamura of the University of Tokyo proposed a large-scale effort to design computer architectures and fulfill the ultimate vision of a "computing everywhere" environment, which is recently acknowledged as "ubiquitous computing" or "pervasive computing." One of the many specifications that resulted from this project, ITRON, has become a de facto standard in the embedded systems market, especially in Japan, where it is widely used in cellular phones and other consumer products (www.embeddedstar.com).

Ubiquitous Computing has roots in many aspects of computing. In its current form, it was first articulated by Mark Weiser in 1988 at the Computer Science Lab at Xerox PARC. Inspired by the social scientists, philosophers, and anthropologists at PARC, we have been trying to take a radical look at what computing and networking ought to be like. We believe that people live through their practices and tacit knowledge so that the most powerful things are those that are effectively invisible in use. This is a challenge that affects all of computer science.

Our preliminary approach: Activate the world. Provide hundreds of wireless computing devices per person per office, of all scales (from 1" displays to wall sized). This has required new work in operating systems, user interfaces, networks, wireless, displays, and many other areas. We call our work "ubiquitous computing". This is different from PDA's, dynabooks, or information at your fingertips. It is invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere (www.ubiq.com).

The Active Badge system provides a means of locating individuals within a building by determining the location of their Active Badge. This small device worn by personnel transmits a unique infra-red signal every 10 seconds. Each office within a building is equipped with one or more networked sensors which detect these transmissions. The location of the badge (and hence its wearer) can thus be determined on the basis of information provided by these sensors (www.uk.research.att.com).

The Affective Computing research group aims to bridge the gap between computational systems and human emotions. Our research addresses machine recognition and modeling of human emotional expression, machine learning of human preferences as communicated by user affect, intelligent computer handling of human emotions, computer communication of affective information between people, affective expression in machines and computational toys, emotion modeling for intelligent machine behavior; tools to help develop human social-emotional skills, and new sensors and devices to help gather, communicate, and express emotional information (www.media.mit.edu).

The Things That Think (TTT) project is based on the idea that everyday objects such as coffee cups, frying pans and toys should use computers to enhance their normal usage. Smart. Things That Think is inventing the future of digitally augmented objects and environments. We bring a unique, boundary-breaking perspective to research, uniting leaders in science, engineering, design, and art. Grounded by extensive corporate sponsor interaction, our prototypes and demonstrations aim to inspire the products and services of tomorrow (ttt.media.mit.edu).

Grid computing enables the virtualization of distributed computing and data resources such as processing, network bandwidth and storage capacity to create a single system image, granting users and applications seamless access to vast IT capabilities. Just as an Internet user views a unified instance of content via the Web, a grid user essentially sees a single, large virtual computer (www-1.ibm.com).

At its core, grid computing is based on an open set of standards and protocols — e.g., Open Grid Services Architecture (OGSA) — that enable communication across heterogeneous, geographically dispersed environments. With grid computing, organizations can optimize computing and data resources, pool them for large capacity workloads, share them across networks and enable collaboration (www-1.ibm.com).

The Smart Dust project is to demonstrate that a complete sensor/communication system can be integrated into a cubic millimeter package. This involves both evolutionary and revolutionary advances in miniaturization, integration, and energy management. We aren't targeting any particular sensor, in fact there is no direct funding for sensor research in the project (but we've got quite a few to choose from based on a decade or two of outstanding MEMS work at Berkeley and elsewhere). We're funded by DARPA, so we will demonstrate Smart Dust with one or more applications of military relevance. In addition, we're pursuing several different applications with commercial importance, and we've got a long list of applications to work on if we only had the time (robotics.eecs.berkeley.edu)

Pervasive computing encompasses the dramatically expanding sphere of computers embedded within and intrinsically part of larger devices. This issue presents an essay and eleven papers on the underlying technologies and the human impact of this field (www.ibm.com). Ubiquitous networks are an IT paradigm comprising network infrastructures featuring broadband, mobile and constant Internet access, diverse information equipment that provides access to Internet Protocol Version 6 (Ipv6), and seamlessly linked interactive contents (www.nri.co.jp).

Peer-to-Peer (P2P) network where all connected PCs, called clients, can talk to one another directly, without having to connect through a centralised server. Each networked PC can act as a server, providing files and other information to any other computer on the network (www.ipnetworks.it). Oxygen Project, In the future, computation will be human-centered. It will be freely available everywhere, like batteries and power sockets, or oxygen in the air we breathe. It will enter the human world, handling our goals and needs and helping us to do more while doing less. We will not need to carry our own devices around with us (oxygen.ics.mit.edu).

The Aware Home Research Initiative (AHRI) is an interdisciplinary research endeavor at the Georgia Institute of Technology that addresses challenges facing the future of domestic technologies. A unique and critical resource in this activity is the Georgia Tech Broadband Institute Residential Laboratory, a three-story, 5040-square-foot home that functions as a living laboratory for interdisciplinary design,

development and evaluation (www.cc.gatech.edu).
U-commerce is a dynamic convergence of the physical and the digital, the interface of brick-and-mortar commerce with Web-based wireless and other next-generation technologies in ways that will create new levels of convenience and value for buyers and sellers (Accenture, 2001). The Smart-Its project is interested in a far-reaching vision of computation embedded in the world. In this vision, mundane everyday artefacts become augmented as soft media, able to enter into dynamic digital relationships.

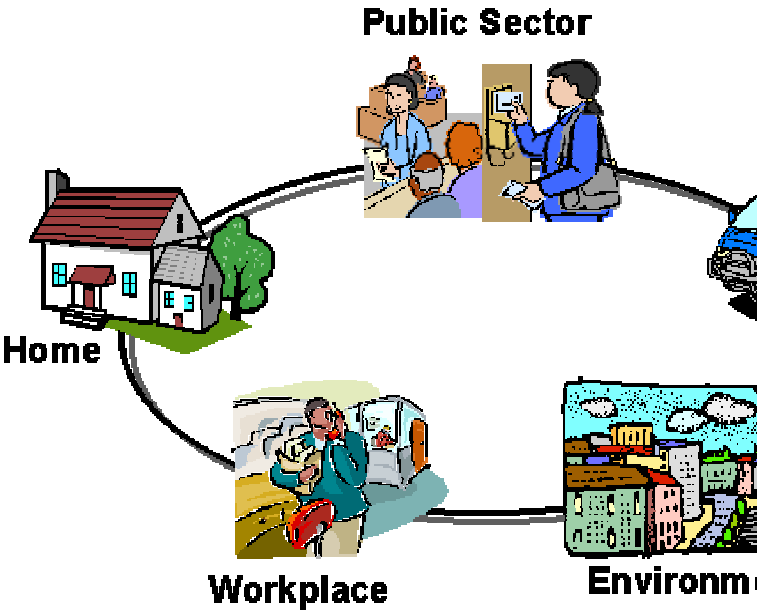
In our project, we approach this vision with development of "Smart-Its" - small-scale embedded devices that can be attached to everyday objects to augment them with sensing, perception, computation, and communication. We think of these "Smart-Its" as enabling technology for building and testing ubiquitous computing scenarios, and we will use them to study emerging functionality and collective context-awareness of information artifacts (www.smart-its.org).

Invisible mobile will pick up where *visible mobile* is beginning to show signs of a slowdown. Not only is the visible mobile sector limited by the number of humans, but also by human limitations and the excruciating financial cost of bringing new mobile services to humans (www.forrester.com).

A new technology from Microsoft Research, called Smart Personal Objects Technology (SPOT), implants always-on wireless connectivity in simple accessories from watches to pendants. SPOT will update your watch with the local time and weather wherever you are via a unique identifier in each device (www.microsoft.com).

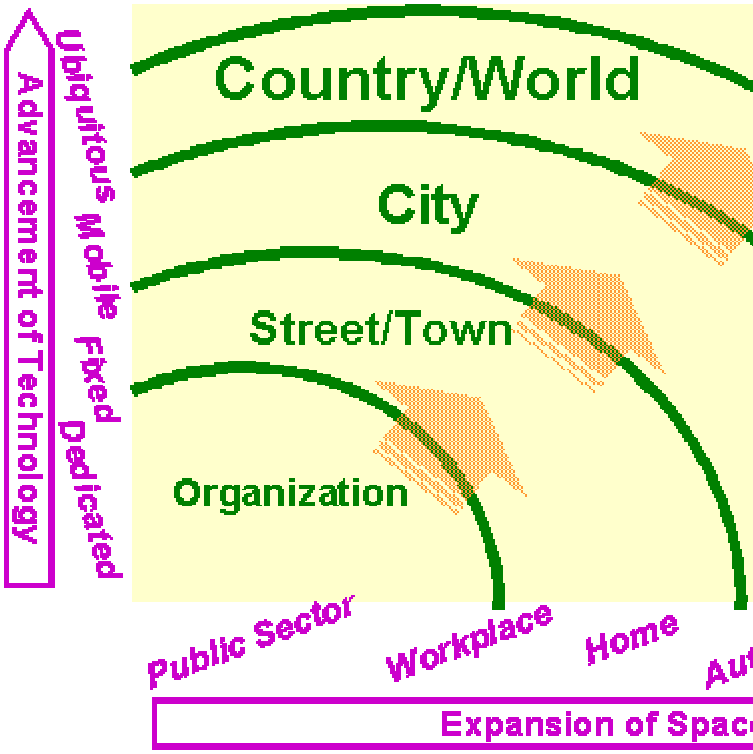
III. Implementation of Ubiquitous Space

The ubiquitous space is expected to be implemented in the five areas in the society: home, workplace, public sector, automobile, environment. (See <Figure 1>.) Each of the areas is expected to become one of the virtual personal area networks (VPAN).



<Figure 1> Five Areas

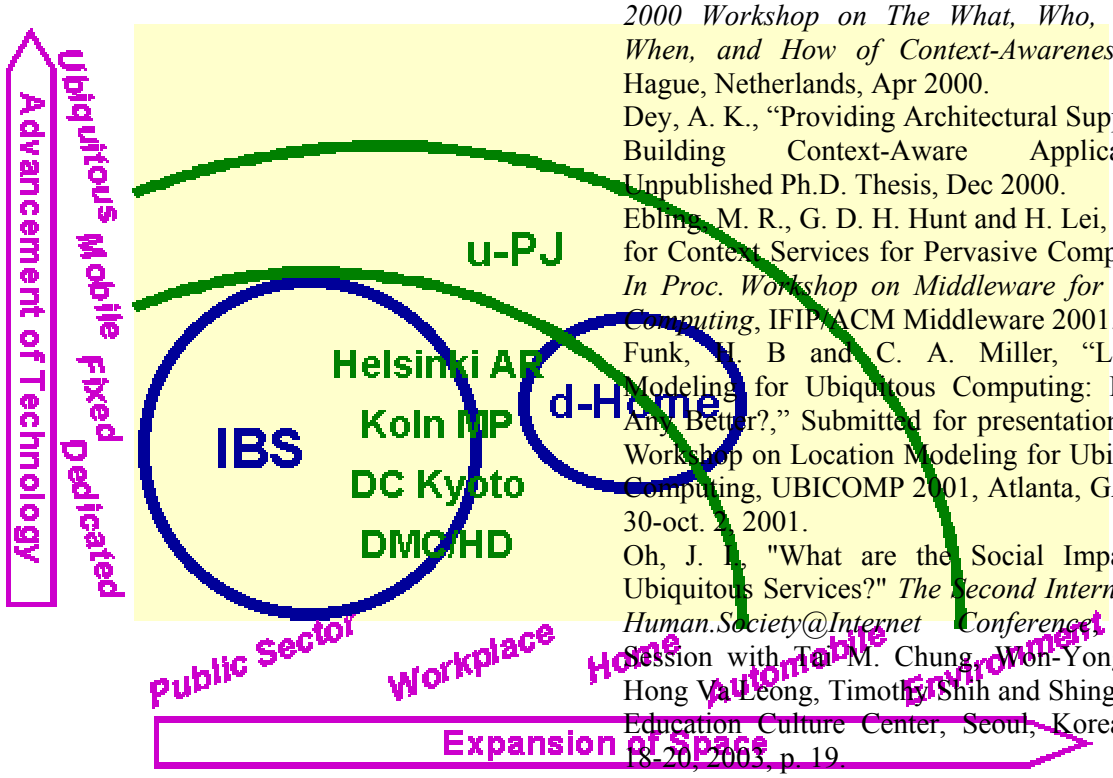
The digital space has been evolved and will be revolutionized in the four stages as in <Figure 2>, based on the expansion of space and the advancement of technology. In the first stage, the domain of the space includes organizations such as public sectors and workplaces and the related technology is mainly dedicated lines and the fixed internet.



<Figure 2> Digital Revolution

In the second stage, the street and town have been digitalized, including homes and part of automobiles and the related technology includes the fixed internet and part of the mobile internet. In the third stage, cities are digitalized and the domain of the space covers automobiles and part of the environment. The related technology includes the mobile internet and part of the ubiquitous solutions. In the last stage, countries and the world in general are digitalized and the ubiquitous computing will be pervasive in the society.

A variety of studies and projects have been conducted in the field of ubiquitous computing toward a digital society. Based on the expansion of space and the advancement of technology, important studies and projects that are going on are mapped in <Figure 3>. The effort is expected to contribute to explaining the characteristics of the studies and projects.



<Figure 3> Paradigm of Projects

The domain of space of the intelligent building system (IBS) includes mainly public sectors and workplaces and the related technology is the fixed internet and part of the mobile internet. The idea of digital homes is focused on homes and the related technology covers the fixed internet and part of the mobile internet.

The digital media city (DMC) and the digital media street (DMS) driven by the city of Seoul include public sectors, workplaces, homes, and part of automobiles. The related technology covers the fixed internet and part of the mobile internet. The project of the u-PJ is the first one in the world, in that the domain of the project covers a city and the related technology includes not only the internet but also the ubiquitous computing.

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