Ubiquitous Computing-Approach to Intelligence Building

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ABSRTACT

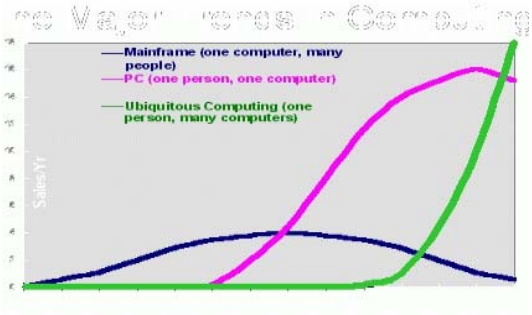
Ubiquitous computing (often abbreviated to "ubicomp") refers to a new genre of computing in which the computer completely permeates the life of the user. In ubiquitous computing, computers become a helpful but invisible force, assisting the user in meeting his or her needs without getting in the way. The Industrial-Organizational Psychologist on website (http://www.ubiq.com/hypertext/weiser/UbiHome.html), Xerox PARC's Mark Weiser, the originator of the term "ubiquitous computing," described it this way: "… [Ubiquitous computing] highest idea one is to make a computer so imbedded, so fitting, so natural, that we use it without even thinking about it."

Keywords: Ubicomp, UC-Ubiquitos Computing

I.INTRODUCTION

A. How Ubiquitous computing is different?

Ubiquitous computing names the third wave in computing, just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of *calm technology*, when technology recedes into the background of our lives.



B.What is ubiquitous Computing?

"It activates the world, makes computers so imbedded, so fitting, so natural, that we use it without even thinking about it, and is invisible, everywhere computing that does not live on a personal

Device of any sort, but is in the woodwork everywhere" (Weiser 1991).

Ubiquitous Computing is often referred to using different terms in different contexts.

Pervasive, 4G mobile and sentient computing or ambient intelligence

● Ubiquitous Computing is NOT:

– virtual reality- real world provides input, not computers!

– A PDA or PC - Called an intimate compute, takes your attention to get it to do the work

● Ubiquitous Computing is:.

– Embodied reality

– Supports a world of fully connected devices.

– Ensures information is accessible everywhere.

– Provides an intuitive, non-intrusive interface, feels like you are doing it

● Ubiquitous computing requires extreme AI.

II.ELEMENTS OF UBIQUITOS COMPUTING

A. Physical and Virtual Integration

Sensing

Information gathering in the physical world
and its representation in the virtual world

Actuation
Decisions in the virtual world and their
Tangible results in the physical world

Awareness and Perception
Using sensed data to maintain a higher-level
model of the physical world and argue about

Ambient Displays
Display information from the virtual world
on physical artifacts

World Modeling
Representations of physical spaces

B. System Components

Platforms
Mobile, wearable or implantable hardware
devices with small form factor

Sensors and Actuators
Hardware and software platforms for sensing
and actuation

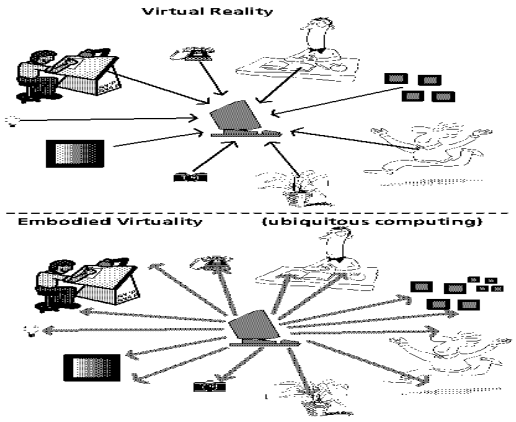
Software Architectures
Adaptable, large scale, complex software
Infrastructures and development

Connectivity
High-speed, low power wired and wireless
Communications systems

C.Ubiquitous Computing Characteristics

● Immerses computers in a real environment
● Sensors support interact with and control the environment.
● Limited power supply, storage, memory and bandwidth.
● Operate unattended (much like embedded systems).
● Devices are mobile/wireless.
● May reside on a person (wearable computing).
● Have special peripherals.
● Contrast this with virtual reality which immerses humans in a
Computer generated artificial environment.

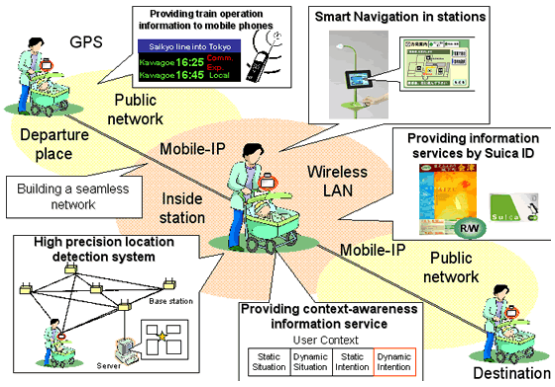
D.Virtual Reality vs. Embodied Reality



Virtual Reality vs Embodied Reality

● **Virtual Reality** –
– Attempts to make a world inside the computer
– Users wear special goggles, gloves, body suites etc
– VR locks users away from reality
– E.g. Games, flight trainers etc
● **Embodied Reality** –
– Invisible computing
– E.g. computers in light switches, thermostats, stereos, ovens etc..
– Location and scale are important in ubiquitous computing
● **Their approach**
– Make aspects of everyday life active
– Network it
  – Build it

E.Working: Ubiquitous Navigation System



III.SOME COMPUTING PARADIGMS

A. Distributed computing

***Distributed computing example*:** You, logging in and web surfing from different terminals on campus. Each web page consists of hypertext, pictures, movies and elements anywhere on the internet.

● Note: network is fixed, YOU move

● Issues:

– Remote communication (RPC),

– Fault tolerance,

– Availability (mirrored servers, etc)

– Caching (for performance)

– Distributed file systems (e.g. Network File System (NFS)

– Security (Password control, authentication, encryption)

B. Nomadic Computing

● *Portable (nomadic) computing example*: I own a

Laptop. Plugs into my home network, sit on couch, surf

Web while watching MTV. In the morning, wake up, unplug, shut down, bring laptop to school, plug into WPI

Network, start up!

●Note: Network is fixed, except for your device and its

Point of attachment. You take your device with you!!

Nomadic Computing Issues:

– File/data pre-fetching

– Caching (to simulate availability)

– Optimistic update policies

– Re-integration and consistency models

– Operation queuing (e.g. emails while disconnected)

– Mobile databases (fragments, objects may shared)

– Resource discovery (closest printer while at home is

not closest printer while at WPI)

●Note: much of the adaptation in **middleware** layer

C. Mobile Computing

Mobile computing:

– Network topology changes, because Mobile users move. Network deals with changing node location

Mobile Computing Issues

– Mobile networking (mobile IP, TCP performance)

– Mobile information access (bandwidth adaptive)

– System-level energy savings (variable CPU speed,

hard disk spin-down, voltage scaling)

– Adaptive applications: (Transcoding proxies, adaptive resource management)

– Location sensing (Use 802.11 signal strength to determine location)

– Resource discovery (e.g. print to closest printer)

D.Ubiquitous Computing

Ubiquitous computing scenario:

– Chicku is leaving home to go and meet his friends.

– While passing the fridge, the fridge sends a message

to his shoe that milk is almost finished.

– When Chicku is passing grocery store, shoe sends

Message to glasses which displays BUY milk Message.

– Chicku buys milk, goes home.

Ubiquitous Computing UC Issues:

– Sensor design (miniaturization, low cost)

– Smart spaces

– Invisibility (room million sensors, minimal user Distraction)

– Localized scalability (more distant, less Communication)

– Uneven conditioning

– Context-awareness (assist user based on her current

Situation)

– Cyber-foraging (servers augment mobile device)

– Self-configuring networks

E. Wearable Computing

● Un-monopolizing of the user's attention.

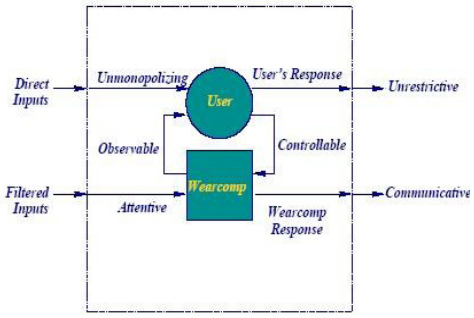
● Unrestrictive to the user ambulatory, mobile, Roving,

● Observable by the user, can alert you when Necessary.

● Controllable by the user: responsive.

● Attentive to the environment:

Environmentally aware. Communicative to Others.



IV.UC TECHNOLOGIES

UC represents amalgamation of quite a number of existing and future technologies like Mobile computing, pervasive computing, wearable computing, embedded computing and location-, context-aware computing technologies fulfill the dream of bringing UC into reality.

V.UC CHALLENGES

It is very tough at present to teach a computer about its environment. The main challenges in ubiquitous computing originate from integrating large-scale mobility with the pervasive computing functionality. In its ultimate form, ubiquitous computing means any computing device, while moving with us, can build incrementally dynamic and intelligent models of its various environments and configure its services accordingly. Furthermore, the devices will be able to either remember past environments they operated in, thus helping us to work when we reenter, or proactively build up services in new environments whenever we enter them.

The shift toward ubiquitous computing poses multiple novel technical, social, and organizational challenges. At the technical level, design and implementation of computing architectures that enable dynamic configuration of ubiquitous services on a large scale, secondly, design and develop ubiquitous services. This needs of feasible and viable architectures, design Ontologies and domain models, requirements and interaction scenarios, and analyzing new families of nonfunctional requirements such as configurability and adaptability.

A. Software Infrastructure and Design Challenges for UC Applications

Ubiquitous computing applications will be embedded in the user's physical environments and integrate seamlessly with their everyday tasks.

- Task Dynamism – UC applications, by virtue of being available everywhere at all times, will have to adapt to the dynamism of users' environments and the resulting uncertainties. In these environments, users may serendipitously change their goals or adapt their actions to a changing environment.
- Device Heterogeneity and Resource Constraints – The omnipresence of UC applications is typically achieved by either making the technological artifacts (devices) move with the user or by having the applications move between devices tracking the user. In both cases, applications have to adapt to changing technological capabilities in their environment.
- Computing in a Social Environment – Another major characteristic of UC technology is that it has a significant impact on the social environments in which it is used. An introduction of a UC environment implies the introduction of sensors, which irrevocably have an impact on the social structure.

VI.RESEARCH CHALLENGES

A. Semantic Modeling - A fundamental necessity for an adaptable and compassable computing environment is the ability to describe the preferences of users and the relevant characteristics of computing components using a high-level semantic model. Ontologies can be used to describe users' task environments, as well as their goals, to enable reasoning about a user's needs and therefore to dynamically adapt to changes. The research challenges in semantic modeling include developing a modeling language to express the rich and complex nature of Ontologies, developing and validating Ontologies for various domains of user activity.

B.Building the Software Infrastructure - An effective software infrastructure for running UC applications must be capable of finding, adapting, and delivering the appropriate applications to the user's computing environment based on the user's context.

C.Developing and Configuring Applications - Currently services are being described using a standard description language and in the future, using standard Ontologies. Such semantic descriptions could enable automatic composition of services, which in turn enables an infrastructure that dynamically adapts to tasks.

D.Validating the user experience - The development of effective methods for testing and evaluating the usage scenarios enabled by pervasive applications is an important area that needs more attention from researchers.

VII.DESIGN OF USER INTERFACES FOR UC

The goal of the merger of ubiquitous and wearable computing should be to provide the right information to the right person at the right place at the right time. The mobile access is the gateway technology required to make information available at any place and at any time. In addition, the computing system should be aware of the user's context not only to be able to respond in an appropriate manner with respect to the user's cognitive and social state but also to anticipate needs of the users.

Speech recognition, position sensing and eye tracking should be common inputs and in the future, stereographic audio and visual output will be coupled with 3D virtual reality information. In addition, heads-up projection displays should allow superposition of information onto the user's environment.

VIII.UC TECHNOLOGIES BENEFITS

The most profound technologies are those that disappear and weave themselves into the fabric of everyday life until they are indistinguishable from it. It will have a profound effect on the way people access and use services, enabling new classes of services that only make sense by virtue of being embedded in the environment.

The possible effects of anytime/anyplace computing on the productivity of an important part of the work force known as knowledge workers are a significant area of speculation and a subject worthy of further exploration. A dramatic increase in access to data and computing by knowledge workers can be achieved technically by mobile computing devices and or by embedding computing devices in products and production technologies. Availability is achieved by embedded systems in products, processes and buildings and by allowing mobile computing input from personnel. The technology release knowledge work from the constraints of a fixed office location and fixed office hours. Knowledge workers can work with full access to communication, data and computing from any location at any time. Unlimited access to computing and communications networks also changes the processes and dynamics of the knowledge work activities of communication, coordination, document sharing, knowledge exchange, and collaboration.

Possible Beneficial Effects of Anytime/Anyplace Computing on Knowledge work

- Enhanced capabilities for communications, coordination, collaboration and knowledge exchange
- Removal of time and space constraints for doing knowledge work
- Access to critical decision makers at any time
- Increased ability to receive and process rich streams of signals about the organization and Its environment

IX.UC INTELLIGENT APPLICATIONS AND ENVIRONMENTS

A. Intelligent Buildings

Creating new dynamic living environments
Realizing Ubiquitous Computing in homes and working
Environments
-Not living with the computer, but merely "inside"the
Computer
-Goal: simplifying or enhancing daily life activities:
• Refrigerator automatically orders food
• Position in bed automatically switches light
• Integrated control of television, Internet and all electric devices
• Remote control from any place
• Automatic heating control through timers and location tracking of
Inhabitants
• Automatic emergency calls through observations
• etc.

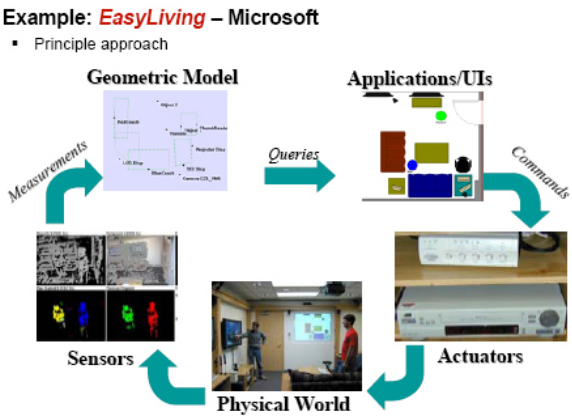
Example: ***The Adaptive House***
-Goal: to maximize the satisfaction of the inhabitants
And minimize energy consumption
-A number of embedded sensors and actors
-"Reactive Environment" using AI self-learning
Technologies (neural networks)
-No administration necessary, no new interfaces or GUIs

-Online tracking of Adaptive House status
-Sensors for
• Sounds
• Temperature

• Movements
• Light
• Switches
-Actors for
• Light
• Heating
• Ventilators
• Sound

Example: *Easy Living* – Microsoft

-1999-2001,
http://research.microsoft.com/easyliving/
-Ubiquitous computing project of the Vision Group at Microsoft Research
-Prototype architecture and technologies for building intelligent environments
• Computer vision for person-tracking and visual user interaction
• Multiple sensor modalities combined
• Use of a geometric model of the world to provide context
• Automatic or semi-automatic sensor calibration and model building
• Fine-grained events and adaptation of the user interface
• Device-independent communication and data protocols

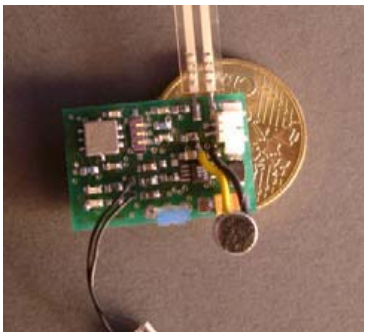


Example: *Smart Media Cup*
-Developed at Teco (University of Karlsruhe)
-Media Cup is an ordinary coffee cup augmented With sensing, processing and communication Capabilities (integrated in the cup's bottom), to collect and communicate general context Information in a given environment.
-Demonstrator is used since September 1999
-What can I do with my Media Cup?
• Detect Meetings
• Send a beep to the watch, when coffee is too hot
• Request ‚brew new coffee' from coffee machine
• Automatically switch to de-caffeinated, if you have to much coffee already.

Example: *Smart-Its*

-Collaboration of Lancaster University, ETH Zurich, University of Karlsruhe (Teco), Interactive Institute and VTT
-The project is part of the European initiative The Disappearing Computer (http://www.disappearing-computer.net)
-Goal:
• Developing small-scale embedded devices that can be attached to everyday objects (like Post-Its) to augment them with sensing, perception, computation, memory, and Communication
• Using Smart-Its to build and test ubiquitous computing scenarios, especially context awareness of information artifacts
-Taco's development system consists of RF Communication and sensor boards, APIs And OS for application development of Smart-Its and PC-based services, and a Bridge for backend (Ethernet /IP) communication

-Smart-Its can be considered as the next generation of smart labels



Example: *Smart Brick*
-University of Illinois, Urbana, USA
-Liu Chang, Jon Engel
(Center for Nanoscale Science and Technology)
-Combination of sensor fusion, signal processing, Wireless technology and basic construction Material into a multi-modal sensor package that Can report building conditions to a remote operator

-The prototype has a thermistor, two-axis accelerometer, Multiplexer, transmitter, antenna and battery hidden inside a brick
-Built into a wall, the brick could monitor a building's
Temperature, vibration and movement
Such information could be vital to firefighters battling
a blazing skyscraper, or to rescue workers ascertaining
The soundness of an earthquake-damaged structure

The problem is, that most buildings use bricks only for decoration

X.CONCLUSION

The grand usage of information technology in fully automating different business, personal, social, enterprise processes gets accepted among the humanity due to its robust benefits. In that direction, a whole lot of innovative technologies (hardware and software) have come out of research labs to reduce the size of computing systems and their components, improve the performance of processors and other components of computing, storage devices, information, Web, consumer, and communication appliances. As a result, we have a world of systems and devices that can connect, communicate and interoperate together towards achieving assigned tasks successfully in a safe, seamless and secure fashion.

Towards achieving the above stated goal and vision of IT community, there are quite a number of research scientists and visionaries working together to bring out the systems architecture, software technologies such as languages, environments, protocols and tools and above all to bring out an array of killer applications. In the years ahead, there will be news and products for facilitating the world of ubiquitous computing.

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