Ubicomp Computing Everywhere Architecture

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Abstract: **"In Marc Weiser's vision of ubiquitous computing, users are located in an environment with potentially thousands of computers around them. Many capabilities of these smart devices can be used only by augmenting the users' senses with a kind of "sixth electronic sense". Thus,Ubiquitous computing (ubicomp) is a post-desktop model of human-computer interaction in which information processing has been thoroughly integrated into everyday objects and activities. In the course of ordinary activities, someone "using" ubiquitous computing engages many computational devices and systems simultaneously, and may not necessarily even be aware that they are doing so. This model is usually considered advancement from the desktop paradigm".**

This paper present a Study of a new flexible and modular network-centered approach of the design of ubiquitous architectures, technology evidences In our concept, a ubiquitous computing is composed of a network of modules. A module can be worn by the user or be stationary in the user's environment. Each is a separate unit with its own processing, memory, I/O, power, and network connection, and provides specific functionality in the network. The modules reveal their abilities and needs to each other and dynamically assemble to form a ubiquitous Environment

Keywords: Distributed Computing, Mobile computing, Sensor Networks, Grid Computing, Smart Dust, Ambience Computing, Mobile IPv6, RFID

I. INTRODUCTION

Ubiquitous computing applications utilize a large number of services and resources surrounding users and help users perform their tasks more efficiently, conveniently, and with minimum distraction.

A ubiquitous computing environment enables users to explicitly define their tasks which are then realized using networking resources and services. These tasks may be requested anytime, anywhere and then constructed at runtime as required by the situation in hand. Service-oriented architectures are among the premier approaches to providing a middleware layer for ubiquitous computing environments. When a service could not accomplish the tasks, service composition should be performed. [6]

Ubiquitous computing raises many security, privacy and trustworthy problems. It requires security architecture based on trust rather than just user authentication and access control that traditional, stand-alone computers and small networks rely on.

Recent progress of wireless technologies has initiated a new trend in learning environments, called ubiquitous learning (u-learning), which is able to sense the situation of the learners, and hence provide more adaptive supports. Ubiquitous computing touches on a wide range of research topics, including distributed computing, mobile computing, sensor networks, human-computer interaction, and intelligence. Hence, three additional forms for ubiquitous systems have been proposed:

Dust: miniaturized devices can be without visual output displays, e.g., Micro Electro-Mechanical Systems (MEMS), ranging from nanometers through micrometers to millimeters. E.g. Smart dust.

Skin: fabrics based upon light emitting and conductive polymers, organic computer devices, can be formed into more flexible non-planar display surfaces and products such as clothes and curtains, see OLED display. MEMS device can also be painted onto various surfaces so that a variety of physical world structures can act as networked surfaces of MEMS.

Clay: ensembles of MEMS can be formed into arbitrary three dimensional shapes as artifacts resembling many different kinds of physical object. E.g. Tangible interface.

II. UBI-COMP PARADIGM

"Present ,appearing and found everywhere".

Paradigm: Extending the internet from virtual domain to real world environment. It consists of calm technology receding in the background of our lives. It is not a singular but a collection of theories and technologies Combining several technologies for creating an integrated service environment Such as RFID

Features: 1.) Context awareness 2.)Adaption 3.) personalization

Necessities for successful concepts:
1.) Not intrusive 2.) Human centric 3.)Transparent

It changes the way we gather, process and share information revolutionizing the way we interact and communicate with people face to face or anywhere in the world.

Application mostly still in prototype stages, sensor network revolutionize the whole industry

Concentration on technological issues rather than user needs

Context aware personal mobile application for smart phones, seamless networking, context log, data interpretation

It creates huge markets for service enablers (technological companies) as well as content providers (web 2.0

derivatives) but its success largely depends on innovative services and the focus on the user

III. CHALLENGES OF UBIQITOUS COMPUTING

To do ubiquitous computing devices must overcome six challenges:

1. The "Accidentally" Smart Environment
2. Impromptu Interoperability
3. No Systems Administrator
4. Social Implications of Aware Technologies
5. Reliability
6. Inference in the Presence of Ambiguity

IV. TAXONOMY OF UBIQUITOUS ENVIRONMENTS

In this taxonomy, we have categorized UbiComp environments in two major classes; Interactive and Smart environments, and further classify each into two subclasses. The former class represents UbiComp environments that support group work, while the latter represents UbiComp environments that support individual work.

2.1) Interactive Environments It represent UbiComp work spaces that support group events. These events include formal group meetings where group members meet to share ideas, or informal meetings which are being formulated in parallel with formal group meeting. Both of these meetings require different computing configurations. The former can be supported by a static computing environment while the latter requires highly flexible computing environment that can be easily transformed to concurrently support both formal and informal group meetings. To differentiate these environments, we have categorized them in two classes; creative spaces and meeting spaces.

2.1.1) Creative Spaces: By creative spaces we refer to UbiComp environments that support creative group meetings. It indicates that more innovative ideas are generated through series of small groups meeting in parallel as opposed to a single formal group meeting. These small meetings may comprise individuals or small groups concentrating on a specific task.

2.1.2) Meeting Spaces: We define meeting spaces as UbiComp environments that facilitate group interactions. These spaces can be simple computing environments with interactive electronic whiteboards and an overhead projector or more complex with additional UbiComp devices such as Digital diaries and Smart phones. The fundamental goal of these environments is to support face-to-face group meetings.

2.2) Smart Environments are UbiComp environments that support to individuals as interactive environments. it occurs on supporting individual's daily operations. The emphasis of smart environments is on observing and reacting, automatically or with minimal user interaction, to the environmental conditions. To differentiate the environments we classify as ambient spaces are smart Spaces.

2.2.1) Ambient Spaces: UbiComp environments that are highly integrated with intelligent gents interconnected with wireless networks to intelligently control the environment and provide a convenient interface to information within that environment. It has richness in information and high level technological invisibility..

2.2.2.) Smart Spaces: In our previous work we have defined Smart Spaces in UbiComp as follows "A highly integrated computing and sensory environment that effectively reasons about the physical and user context of the space to transparently act on human desires" By highly integrated we meant an environment that is highly heterogeneous with many sensors to provide a coherent view of the environment; by effectively reason, we meant a pseudo-intelligent reasoning mechanism for the environment as a whole; by user context, we referred to an individuals computational desires, current location and mobility status; finally by transparently act, we meant an environment that is self responsive or requires minimum user interaction.

2.3) Wearable Computing: Commercially available wearable or research prototypes are basically standard personal computers with a hardware design that allows them to be worn on the waist or in a vest. The core is a box with the CPU that controls the entire functionality.Other devices are peripherals that are connected via USB, FireWire, or some other interface to this box

. Other designs with a flexible circuitry allow one to assemble several microcomputer cards into a wearable computer, but the basic platform concept is the classical architecture of the personal computer.

The software that makes the peripheral devices useful runs on the CPU of the wearable, not the peripheral device. The modular concept and the powerful platforms are a good base for the development of wearable computers.

Our wearable is composed of modules where each of them is a complete computer with CPU, memory, I/O, and network connection. This allows us to develop applications on a higher level of abstraction with component-based software engineering techniques.

V. OBJECTIVES

The objective of ubiquitous computing is to move interaction with computers out of a person's central focus and into the user's peripheral attention where they can be used subconsciously. Ubiquitous computing is often characterized by the attributes of mobility, interconnectivity and context-awareness.[3]

1.) Tool metaphor: The user needs a set of tools that can be combined very simply by plugging hardware together.. For example, for voice recognition, the microphone should be connected to a hardware module that runs complete voice recognition software.

2.)User comfort and energy reduction: One important issue is user comfort. In studies it was shown that it would be best to distribute parts of the wearable computer on different parts of the human body [2]. Another important issue is energy consumption. For example, user tracking can be more or less precise. If a lower accuracy is acceptable for a specific task, a more accurate tracking device that is awkward to wear maybe left in the tool box.

3.)Dynamic integration: With ad hoc communication of modules within the network of the wearable multi-computer we can also extend its range. This means that services in the environment that come within reach can be integrated and used. An example is distributed user tracking concepts for augmented reality applications.

4.)Resource sharing: The admin of a smart space exposes a service accessible to visitors over wireless network. For Example: Two employees of the same company exchange a document between their mobile phone at a conference or A nurse take a wireless heart-rate monitor from a box, attaches it to patient.

5.)Applications: An application module is a module that contains functionality for the user. Usually it has only needs but no abilities for other modules. It also runs on a hardware component and the user can attach it to the system when needed. At startup, the application module checks if all needs can be matched. If so, the application starts offering services to the user. Usually there will be more than one application module on the wearable. Instead of installing application software on one module the user clips a new application onto his belt when needed.

6.)Framework: In a system that consists of a set of components and their services, a framework describes the interfaces and dependencies between the components and the architecture of the system. It allows families of applications to be developed that reuse the components of the framework. Once there is a set of components available, new components and applications can be developed that use the existing infrastructure. Services providing the same type of ability, but using different techniques, can be exchanged for testing purposes as well as in final systems. The interfaces between the modules must be specified in advance not only syntactically for the data types but also for the quality of the data. One example for such a standard interface that occurs quite often in wearable computing is the position of an object in six-dimensional coordinates, including parameters for quality of tracking accuracy.

7.)Modules Every module has at least one specific function, such as a camera module for capturing video data, a gaps receiver module for positioning, or a head-mounted display module for displaying data. There can also be modules the user does not directly interact with—these only provide internal services such as a map of the world to be shown on the display module.

Every module is self-contained as a physical device consisting of the hardware and all necessary software for the specific functionality as well as for the communication with other modules. Each module must have a service manager. The user simply has to switch on the device and, if necessary, perform some minimal configuration; the integration with the other parts of the system is established by the service manager automatically after the module starts up.

8.)Services, Needs and Abilities A service is a piece of software running on a module that provides certain functionality. To let the services interact, we associate them with several *needs* and several *abilities*. The abilities can be used by other modules if and only if all needs of the service can be fulfilled by services of other modules. Each need and ability has a specific type, and abilities can be fulfilled only by needs of the same type. Also, a need can have a multiplicity indicating how many abilities of the same type are required to fulfill this need.

9.)Quality Parameters. For a good match between the needs and abilities, it is not enough only to match the types. Information about the quality of the offered abilities and about the required quality of needs is important. An example is tracking accuracy. Therefore, each ability has a set of attributes describing quality-of-service parameters of that service. This predicate is used by the service manager to select abilities that can provide a sufficient quality of service to satisfy a given need.

10.) Service Description: To let the service managers know the quality of-service parameters, each module needs a set of appropriate service descriptions. These are then used by the service manager to match the needs and abilities. Every service has to describe itself at startup time to the module's service manager. Another possibility is to store descriptions of installed services with the service manager, which can then start the services on demand when their abilities are requested, conserving resources such as battery power. This may be done using xml.

11.)Dynamic Configuration: Each module has a service manager to enable dynamic configuration. The different local service managers communicate over the network, using protocols such as slp (Service Location Protocol) , and distribute the information about the services with their needs and abilities. When eventually all needs of a service can be fulfilled by abilities of other services, the service managers create *Dynamic Connections* between the corresponding needs and abilities. These allocate and configure the necessary communication resources like event channels or shared memory blocks on both ends of the connection. The services can access the communication resources through the connections and use them to communicate with one another. The advantage of this is that two services can decide on the best way to communicate before they actually start communicating. There is no communication overhead at application runtime. To connect the services of two different modules no additional user interaction besides plugging the hardware together is necessary.

VI. TECHNOLOGIES FOR UBIQUITOUS COMPUTING

4.1) Mobile IPv6:

There exist some characteristics of IPV6 which are attractive to WSN in its possible integration.

Enlarge address space: Mobile IPv6 will help solve the addressing problem.

Identification and security: This improvement makes IPV6 more fit to those commercial applications that need sensitive information and resources.
Access Control: We can make identification and add some access control according to different username. IPV6 also proposes force management about consistency that can prevent the data from modifying during the transmission and resist the rebroadcast aggression.
Auto-configuration: IPV6 supports plug and play network connection. Power consumption is another issue. But if we want to apply IPV6 in WSN, we must reduce its power consumption.
This can be realized through using duty-cycle model.

4.2) RFID Technology:

RFID tag is the key device for the actualization of "context awareness", which is essence of ubiquitous computing and can recognize "data carriers" by electronic wave without physical contact. Contact-less chips in RFID do not have batteries; they operate using the energy they receive from signals sent by a reader. In context of integration of RFID technology into wireless sensor networks, probably, the most prominent integration application will be in the field of retail business. Some of the disadvantages which make room for integration of RFID with WSN are • Inability of RFID to successfully track the target object (customer) within a specified working space (department floor, exhibition etc.). Deployment of RFID systems on already existed working spaces. For example, if we have to deploy RFID on a department floor, it will be prohibitively expensive to do so. In this regard, [16] has presented a scheme to implement the combined RFID and WSN technologies in enhancing the customer relationship management for a retail business.

4.3) GRID Technology:

Grid Computing delivers on the potential in the growth and abundance of network connected systems and bandwidth: computation, collaboration and communication over the advanced web. At the heart of Grid Computing is a computing infrastructure that provides dependable, consistent, pervasive and inexpensive access to computational capabilities.
The main driving force behind grid computing is the desire to take advantage of idle resources in a network and use these in intensive computations. With a grid, networked resources -- desktops, servers, storage, databases, even scientific instruments – can be combined to deploy massive computing power wherever and whenever it is needed most.

Wireless grid technology has already got boost by some good progress in availability of compatible hardware. Wi-Fi technology and WLAN are supposed to play a key role in making wireless grid reality. The wireless grid architecture represents a combination of high-performance LAN switches with structured WLAN distribution systems and is believed to be a key development for the industry. It is well set to integrate into the future densely deployed wireless sensor networks.

4.4) Mobile P2P:

Mobile P2P can be simply defined as transferring data from one mobile phone to another. Some of the limitations that become challenges for mobile P2P to be implemented are low efficiency (in terms of CPU and Memory), low power, low bandwidth and billing issues.
This concept basically presents the peer-to-peer networking concept that is widely in use today in fixed communication networks, but mapped to mobile environment. Each sensor network presents a peer node capable of working and providing information independently of other peers, but also of communicating with other nodes and sharing available information with them.
Collaboration of completely uncoordinated and nomadic networks on execution of a common task in a mobile environment is obviously not easy to implement. Different types of information and services, various data formats and application requirements, connectivity of and ability to discover sensor networks connected to different mobile networks are some of the most interesting issues.
An idea can be to expose the WSN to a P2P network and enable the UPnP (Universal Plug n Play) Gateway to discover remote sensor nodes through the P2P substrate and to instantiate UPnP proxies for them to ensure client connectivity.

VII. SECURITY ISSUES

The information security concepts presented as
Why Security?
Privacy (confidentiality), Authentication
Integrity, Non-repudiation
Ubiquitous Computing means that computers are increasingly involved in all aspects of everyday life. IT security gets interwoven with 'human security' i.e. individual and public security including privacy and trust, even safety and dependability. IT security issues become ubiquitous since virtually any (non) action in daily life can potentially imply juridical or financial consequences, and even the most banal activities cause privacy concerns when 'observed' by computers.
The area security for ubiquitous computing has identified three major challenges in this context:[7]

1. Anthropomorphic security and trust concepts: today, human security is based on different principles and models than IT security. For example, humans are used to learn from their experiences and to deal with imperfect information, while those aspects are hardly integrated in current IT security solutions. Such differences must be minimized or the implications and required actions must be conveyed in a 'human-compliant' manner. The transfer and integration of current security solutions in everyday life devices leads to new challenges. The usability of security mechanisms must be dramatically improved. Finally, the increasing concerns about public security must be addressed with the help of ubiquitous computing approaches.
2.Security Mechanisms with customizable tradeoffs: since security comes at a cost and never attains 100%, the cost-

security tradeoff must be conveyed to users and made customizable; even more important, privacy and traceability (e.g., in case of illegal action) as well as adaptively (e.g., to an observed user behavior) form a tradeoff; in daily life, legislation reflects this tradeoff and changes over time and between regions/cultures; IT security must be made customizable to reflect this tradeoff.
3.Scalable Approaches to security: present IT security solutions do not scale up to zillions of loosely and unreliably interconnected devices where little prior knowledge exists (cf. end-to-end encryption and of public key infrastructures); new approaches must be developed to face these changes.

VIII. FUTURE APPLICATION SCENARIOS

The possible application scenarios for traditional wireless sensor networks, which are envisaged at the moment, include environmental monitoring, military surveillance digitally equipped homes, health monitoring, manufacturing monitoring, conference, vehicle tracking and detection (telemetric) and monitoring inventory control . Since, mobile wireless sensor networks are a relatively new concept; its specific, unique application areas are yet to be clearly defined. Most of its application scenarios are the same as that of traditional wireless sensor networks, with the only difference of mobility of mobile sink, preferably in the form of mobile phones. We, however, envisage a space where sensors will be placed everywhere around us, a concept of ubiquitous network, where different promising technologies will work together to help realize the dream of late Marc Weiser. We propose that with these sensors placed everywhere, a single individual mobile phone can enter into a "session" with the "current sensor network" in which he or she is present. A mobile phone will have the necessary interfaces available to allow it to communicate with the heterogeneous world. In most of the cases, this mobile phone will "enter" into the network as one of the mobile sinks. This way, a mobile phone can enter into the session anywhere at any time; at airport, railway station, commercial buildings, library, parks, buses, home etc. We will now discuss some of the possible application scenarios in ubiquitous computing age as a motivation for future work. [2]

Smart Transport System: One way in which mobile wireless sensor networks can help is through implementing an intelligent traffic system. With the sensors placed frequently around the city, these sensors can monitor and analyze the current traffic system at these areas at a given time. This information is delivered back to a central gateway or sink, having a link to different mobile phone operators, which in turn can provide this "traffic help" service to its customers, on demand.
Security: Similarly, with these sensors placed everywhere in and around the city, these very sensors can be used to implement security system in daily life. On an individual basis, a mobile phone of a person can enter into a "session" with the already present sensors in the area. In this way, it can keep a track of his belongings, car and even kids.

Social Interaction:. There is a rapid increase in number of mobile subscribers in the world. We believe that with the possible integration of RFID tags and WSN, mobile phones can act as sinks to have a "social interaction" among peers who share the common interest. People can place their digital tags at their places of choice, or among their friends. Similarly, this combination of RFID tags and WSN can help mobile phones users in using their mobile phones as "single" tool to carry out all their tasks, be it shopping, billing, information gathering, guidance, social interaction, etc. By entering into a "session" with existing sensors or WSN in a particular area, the mobile phone user can get the necessary information on his mobile phone, like the location of his friends/relatives, the time table/schedule of the events taking place, environmental conditions etc. With the help of little initial information about the user, it is also possible to enter into any area, shop around, buy digital tickets and simply walk off, all with electronic billing. The same idea can be implemented in the form of e-voting in elections ranging from company elections to elections on much larger scale. "Context Aware" computation will be a significant key player in helping mobile WSN in social areas. Coupled with the superior image recognition techniques built in, people can interact with each other and with the environment. This single advancement in technology can have an enormous application potential, more than what we can imagine at the moment. [5]
Health: One area which is already showing such signs of applications of ubiquitous computing is health monitoring. Emerging developments in this area are providing the means for people to increase their level of care and independence with specific applications in heart monitoring and retirement care. In recent years, one area of increasing interest is the adaptation of "micro grid" technology to operate in and around the human body, connected via a wireless body area network (WBAN). There are many potential applications that will be based on WBAN technology, including medical sensing and control, wearable computing, location awareness and identification. However, we consider only a WBAN formed from implanted medical sensors. Such devices are being and will be used to monitor and control medical conditions such as coronary care, diabetes, optical aids, bladder control, muscle stimulants etc. The advantages of networking medical sensors will be to spread the memory load, processing load, and improving the access to data. One of the crucial areas in implanting sensors is the battery lifetime. Batteries cannot be replaced or recharged without employing a serious medical procedure so it is expected that battery powered medical devices placed inside the body should last for ten to fifteen years. Networking places an extra demand on the transceiver and processing operations of the sensor resulting in increased power consumption. A network placed under a hard energy constraint must therefore ensure that all sensors are powered down or in sleep mode when not in active use, yet still provide communications without significant latency when required.
Miscellaneous Scenarios: We focus to concentrate on creating a smart world where a single user mobile phone

can perform a multitude of applications. We envisage a scenario, where wireless sensor networks will be placed every where around the "smart" city

IX. SUMMARY AND CONCLUSION

Many research communities in Ubiquitous Computing have researched and developed Ubiquitous Computing environments. Unfortunately, there is no clear understanding of what are their similarities and differences. In our previous work in Ubiquitous Computing environments we realized that most of these environments have been incorrectly categorized. In this paper we have proposed taxonomy for classifying Ubiquitous Computing environments. We have characterized these environments based on their purposes and functionalities. In our proposed taxonomy, we have categorized Ubiquitous Computing environments into Interactive and Smart environments. Interactive environments represent Ubiquitous computing environments that explicitly support collaborative group work, while Smart environments represent environments that supports individual's daily activities. To demonstrate the applicability of the proposed taxonomy, we reviewed existing Ubiquitous Computing environments and classify them according to the new taxonomy.

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