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UBIQUITOUS COMPUTING: ADVANTAGES AND CHALLENGES

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Abstract: Ubiquitous computing is a relatively newer concept in terms of its actual implementation and further incorporation into everyday devices. It is a concept concerned with everywhere computing and does not live on any individual device but is in the woodwork. Ubiquitous computing (also called pervasive computing) is the growing trend towards embedding microprocessors in everyday objects so they can communicate information and make intelligent actions possible. The sharing of resources between physical and virtual worlds requires a particular kind of interaction to take place. And this makes it difficult to separate digital and physical security. This paper will presents an overview of the ubiquitous computing, the early work done in this field, examples from real life, advantages and challenges.
Keywords: Ubiquitous, computing, Ubicomp, Pervasive.

1. Introduction:

With the help of ubiquitous computing we aim to create pervasive devices that are always interlinked. The devices are connected to the Internet and the data they generate is easily available. Pervasive computing relies on the intelligent combination of wireless technologies, advanced electronics and the Internet.[1]

As a result it is clear that security of devices and the data that is involved in these devices is widely exposed to an array of sources that may genuinely also need this information but at the same time make it highly vulnerable to sensitive information being available in the hands of those who may misuse the same and not only cause damage to the system involved but use it elsewhere as a cheat or result in identity theft.

This paradigm shifting technology changes the way we interact with computers, devices, humans and physical spaces. It envisions a world with microprocessors, electronically embedded devices easily available without any barriers related to place or time.

This takes place in an environment that integrates physical and computational aspects of the environment. It involves deployment of numerous computing devices and censors that improve functionality, offer specialized services and boost productivity and interaction. [2]

Generations in Computing: There are various generations of computing depending on the interaction between users and computing devices and how they vary in number.

i) Mainframe computing: This kind of computing involves just one computer and numerous users of the system.
ii) Personal computers: This involves a single computer and a single user of the system.
iii) Ubiquitous Computing: This involves one person and various computing devices.

Virtual World and Relation to Ubicomp: UbiComp is roughly the opposite of virtual reality. Where virtual reality puts people inside a computer-generated world, ubiquitous computing makes it necessary for the computer to live as a part of the real world with people. Virtual reality is basically a concern of actually implementing equipment for use, ubiquitous computing is a very difficult assimilation of human factors, computer science, engineering, and social sciences.

Hence it makes it very difficult to ensure that all the devices that are in the real world and closely compatible with each other so that we can make use data and information across both the platforms.

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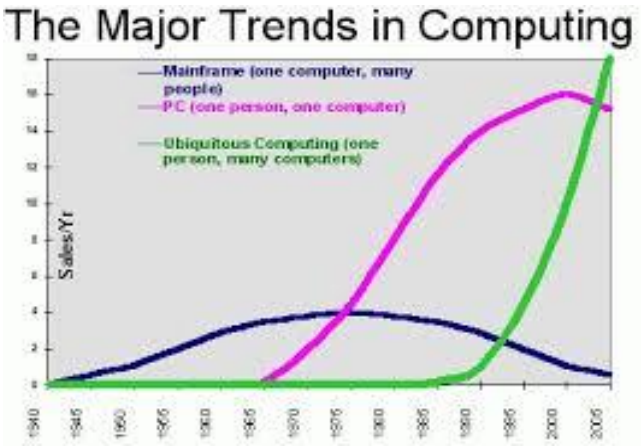

Fig 1.1 Major trends in Computing [11]

As the above graph shows, the descent into ubiquitous technology was mot sudden. It took about 25 years for a technology like mainframe computing to settle itself and this period was silent for the UbiComp. Then from 1965 we saw the rise of the Personal Computers era of technology. Subsequently, 1990s saw the rise of one user and many devices era of technology. This was the dawn of Ubiquitous computing that slowly began with wireless technology and tabs, pads and boards.

2. EVOLUTION OF UBIQUITOUS COMPUTING:

The initial incarnation of ubiquitous computing with "tabs", "pads", and "boards" built at Xerox PARC, 1988-1994. Many papers recognize this work, and there are web pages for the Tabs and for the Boards (being a commercial product now):
Ubicomp helped kick start the recent innovation in mobile computing research, although it is not the same thing as mobile computing, or a superset or a subset.
Ubiquitous Computing has its base in many aspects of computing. [3] The history of wearable technology takes us back to ubiquitous computing and the innovation in of wearable computers. An early item of wearable technology was the hearing aid. It is a device for the deaf in order to improve hearing so that they can hear in a better way. These devices are known as medical devices. In 1980, the calculator watch was highly popular. In 2004, the Hug-shirt was invented in Spain. The hidden Bluetooth microphone was invented by Lyle Freidman in 2008.[4]
An Example: An example of a practical application of pervasive computing is the replacement of old electric meters with smart meters. In the past, electric meters had to be read by a company employee allotted for the job. Smart meters report usage in real-time over the Internet. They will also notify the power company when there is an outage, auto-set thermostats according to the homeowner's directives, sends feedback to display units in the home and regulate the water heater.

3. BENEFITS OF UBIQUITOUS COMPUTING:

- Ubiquitous computing proves useful to users by combining sensors, networking and data technology analytics to monitor and report on many different things, from purchasing preferences to manufacturing processes to traffic patterns.
- Such computing units can easily detect anomalies or errors and emissions in a work environment, enabling early intervention or preventing a workplace disaster.
- Ubiquitous computing can also keep record of resource usage, inputs as well as outputs, allowing for better management of resources during times of high load or for better distribution of resources across a time frame.
- The initiation of ubiquitous computing sensors and networks to rural areas can also enable the delivery of services to rural areas and others deprived of such services. Medical services which are basic necessities of human life may be expanded beyond the location of a hospital or a clinic, with doctors being able to monitor patient health abnormalities from great distances.

- Education privileges to backward regions can also be evolved through by use of interactive media delivery technology, allowing students and professors to communicate in a personal context without the need to be in the same physical environment.
- In a home infused by ubiquitous computing, intelligent lighting and air conditioning systems could contact sensors to monitor the residents surrounding temperature based on the body scans.
- Digital information and services are going mobile and can be called up from any location. A trend towards ubiquitous computing is emerging- that is, the ubiquitous and invisible use, creation, processing, transmission and storage of information[12]
- Using the data extracted from sensors, the smart home can accordingly change temperature and lighting to maintain a maximally comfortable environment. A system like that can reduce waste and aid environmental sustainability. [4]
- If one focuses on its usage commercially then with proper attention to security UbiComp can make it more productive to create a network of devices that not only connect together but also provide efficiency in retrieving results. As it provides ease of usage and does not require for users to make manual adjustments and directly adjust the necessary information as and when required by the user.

4. CHALLENGES:

- Though this technology can make many mundane activities faster and more efficient, ubiquitous systems may threaten privacy and create questions surrounding user consent. Privacy is also important as users need to be confident that their personal information is not used in a way that they do not approve of.[13]
- It is potentially difficult to implement pervasive computing while maintaining proper privacy standards. Ubiquitous systems contain a magnitude of sensitive personal data, and managing this data involves navigating various challenges.
- It could create ethical problems that may require user consent. With few exceptions, individuals have traditionally used computer systems consensually. If this concept extends to each and every aspect of people's lives, this could force people to engage without consent. In fact, individuals might well interact with these systems unwittingly.
- The accidentally smart environment: The world does not readily offer a suitable environment. In fact, it is already suited to certain well-established technologies. So the current environment of the user must be "upgraded" in order to support ubiquitous devices.
- Impromptu interoperability: The devices must not only be interoperable but also have impromptu interoperability, which means that they must be able to inter connect and communicate with little or no advance pre planning.
- The problem here is that every device's software must be written to understand every other's software.
- Social implications of aware technologies: Pervasive computing may have implications for privacy, security and safety as a result of its ability to gather sensitive data, for example, relating to user's everyday interactions, movements, preferences and attitudes without user intervention and consent.
- The advent of pervasive computing may mean collection of information without the knowledge of the user. Some say that this could violate the existing data protection law.
- Reliable: Since this technology is going to be everywhere it will have to be reliable.[8]
- The user will not want to be constantly bombarded with failing devices and insecure softwares. [5]
- Confidentiality: This is one of the major concerns when it comes to connecting devices over a network. The use of this information must be done by an authorized set of users. But this is precisely what ubiquitous computing does not ensure.
- Integrity: This implies that the information be modifiable by very selective users. Those that are authorized by legal and verified sources and actually deserve access to information. However Ubiquitous Computing needs to create a network of devices and interconnection between them. And hence compromise of security and probable misuse is somehow possible.
- Availability: The information must be available as and when required but access is not always possible due to impromptu interoperability issues. Thus making each connected object ready for interconnection is also necessary for ensuring proper communication of devices and availability.[9]

5. RECENT ADVANCEMENTS:

The most recent innovations in wearable technology include a device called Movesense. Movesense is used to measure the motion in various types of sports and user can do it using applications that they themselves have created. The device helps us to avoid unnecessary wastage on hardware development and instead allows the user to focus on their personal skill development. For example, we require an application which gives the output of end user value. Sports and motion sensing is the next thing after GPS and heart rate measurement. With the use of these concepts, we can enable tracking and analyzing strength, team tactics, skills and much more. The revolutionary wearable technology, named Kakoon, was innovated by the end of 2016. It is the first ever sleep- sensing headphone. It is intelligent enough to make adjustments to sounds in real time and help us relax and focus. Kakoon adapts to our surrounding audible atmosphere by hearing the sounds around us. It quiets the nearby environment. An interesting gadget is Nuzzle. Nuzzle is a pet tracking device and is based on a GPS system. Nuzzle is placed around the neck of the pet. It helps the owner to keep track of the pet and avoid it from wandering off. Nuzzle has a range of certain distance. It can keep track of the pet's activity as well and also includes GPS mapping features. We will soon see a time when these wearable devices will be incorporated in our everyday jewelry. They will measure biometric data, the level of your activity and motion. Today there is quite some need for jewelry, watches, other wearables electronic devices such as hearing devices and other objects that are worn by the person. [5]

Table 1: DIFFERENCE BETWEEN UBIQUITOUS AND PERVASIVE COMPUTING: [6]

UBIQUITOUS COMPUTING	PERVASIVE COMPUTING
Ubiquitous means everywhere	Pervasive means infused in each aspect of our daily lives. In technical terms, both seem to be somewhat similar concepts.
Ubiquitous computing would be everywhere	pervasive computing would be in all parts of life.[7]
This might mean seeing kiosks on every street corner	This might imply finding that you could -- or need to -- use your Palm handheld to do absolutely every information-based task.
Ubiquitous computing, though, eschews our need to use computers entirely. Instead it includes computing in the backend, with technology embedded in the things we already use. An example is automotors navigation system that, by gaining access to satellite pictures, it notifies us to a traffic jam ahead, or an oven that shuts off when our food is cooked.	Pervasive computing involves devices like handhelds through which it is possible for us get information on anything and everything. That's the sort of thing that Web-enabled cell phones promise.

Conclusion

Ubiquitous computing as a whole concept is definitely evolving. As we see in the paper, it has a recent history of developments and has most definitely taken over the day to day objects. And it has presented the users with various advantages but at the same time it poses various challenges to the society that values the security of the information more than it seeks ease. However, it is not entirely possible to address all the security problems due to limited security resources. We can use threat models based on use cases. Due to widespread interoperability, security still remains a challenge but the multitude of benefits also stand valid if are able to secure the same.

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A Brief Author Biography

Dr. Shahnaz Fatima is MCA and Ph.d. She has completed her ph.d from Integral University. Her research area is Human computer interaction. Currently she is working as an Asst. Professor in Amity University. Dr. Shahnaz Fatima has published many of the valuable research papers in various national and international conferences and journals. She is the member of International Association of Computer Science and Information Technology (IACSIT).

