Title Ubiquitous Computing: A Brief Review of Impacts and Issues

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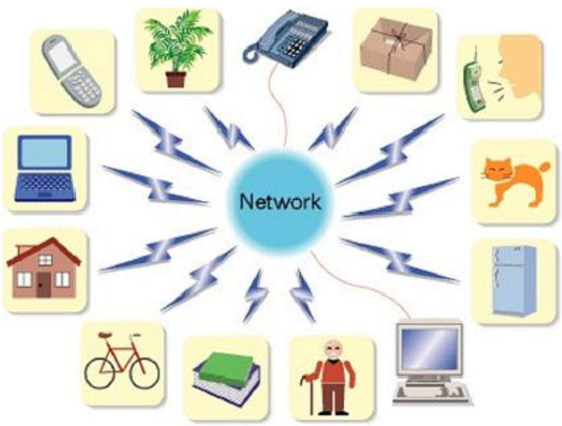
Abstract: The rapid evolution of state of the art technologies has blended inadvertently into the physical world that now offer more than ubiquitous availability of computing infrastructure and resources. Over the past decade we are witnessing new paradigms of application driven computing capabilities by constant access to information and computational capabilities. Application driven Ubicomp has fundamentally changed the relationship between humans and computers, making them indispensable yet providing continuous interaction. The rapid evolution of state of the art technologies have blended inadvertently into the physical world that now offer more than ubiquitous availability of computing infrastructure and resources. Ubicomp has resulted in interaction of natural interfaces, context-aware applications, and automated capture and access. The aim of this paper is to highlight the impact of currently available ubiquitous computing technology on business processes in variety of domains. It briefly discusses technologies and its drivers, and gives some examples of their application including automatic identification, localization, and sensor technology technologies that appear to have impacted business processes in a variety of ways. The paper closes with some future perspectives on ubiquitous computing applications and visits some areas of issues and challenges posed by it.

Keywords: Ubiquitous Computing, Pervasive Computing, RFID, Context-ware Applications, Human Computer Interaction.

1. Introduction

Ubiquitous computing has emerged as a significant revolutionary factor in the field of Information Communication Technology (ICT). It has incessantly gained momentum as a result of latest technological advances in the IT industry over the last decade. We witness countless number of tiny computers embedded and so called, woven, into the fabric of our daily lifestyle. These tiny computers with onboard sensors and actuators communicate with other devices in our live environment. These miniature computers provide ubiquitous computing resources that enable access to anything, by anyone, at anytime and anywhere. Mark Weiser coined the term “ubiquitous computing” in 1988, to describe a future world where invisible computers will be thoroughly embedded in everyday objects to enable everyday activities. “Our computers should be like our childhood: an invisible foundation that is quickly forgotten but always with us, and effortlessly used throughout our lives.”(Weiser). When he reported on his vision (Weiser, 1991), a new research field opened up. The terms “pervasive computing”, “ambient intelligence” and “everyware” are also used equivalently, to focus on a different aspect of the same paradigm. Ubiquitous means “present everywhere”, while pervasive means “penetrate everywhere”. Wireless, mobile, and sensor technologies have now become affordable and embedded into our society which is now taken for granted and indispensable.

(Friedewald & Raabe, 2010) Ubiquitous computing is considered as a promising technological path of innovation. Intensive R&D activities and political strategies are addressing the objective to foster marketable technologies and applications. Not only this computing has simplified ICT applications down to the lowest level but has established a strong adherence with healthcare systems, homes, logistics, retailing, aviation, higher education, and beyond. Computing resources are distributed and the devices no longer require a tech savvy individual to operate them. These are often intelligent enough to operate independently. Nowadays pervasive computing matures from a research topic to a commercial reality (Ye, Dobson, & McKeevar, 2012). Pervasive computing applications include smart homes, health monitoring and assistance, gaming, transportation and logistics. Another concept related with pervasive computing, is the Internet of Things (IoT) (Ashton, 2009), (SRI Consulting Business Intelligence/National Intelligence Council, 2008), (Uckelmann, Harrison, & Michahelles, 2011), (Guo, Zhang, & Wang, 2011), (Van Kranenburg, 2008). The Things are uniquely identifiable everyday objects that will be gradually connected to the Internet in some way. They will be “readable, recognizable, locatable, addressable, and/or controllable via the Internet—whether via RFID, wireless LAN, wide-area network, or other means" (SRI Consulting Business Intelligence/National Intelligence Council, 2008). They will get information about their position in the world and interact with other objects to exchange, compare, and integrate data (Marinagi, Belsis, & Skourlas, New directions for pervasive computing in logistics, 2013).



Ubiquitous computing will enable diverse wireless applications, including monitoring of pets and houseplants, operation of appliances, keeping track of books and bicycles, and much more. (O'Reilly,Sarah 2013)

2. Literature Review

Pervasive computing, ubiquitous computing, and ambient intelligence are concepts evolving in a surfeit of applications in almost every setting. The pervasive computing is loosely associated with the further spreading of miniaturized mobile or embedded information and communication technologies (ICT) with some degree of 'intelligence', network connectivity and advanced user interfaces. Because of its ubiquitous and unobtrusive analytical, diagnostic, supportive, information and documentary functions, pervasive computing is predicted to improve human-computer interaction. The capability of pervasive computing makes it a tool to advancing the shift towards automatic documentation of activities, process control or the right information in specific work situations. On the other hand, the social, economic, ethical, and privacy concerns regarding the use of pervasive computing are also some areas that deter and detract from its acceptance and societal desirability. This short paper highlights the positive effects of ubiquitous computing by providing a systematic overview, analysis of developments, and implementations of pervasive computing in different settings and its impact in deployment. This literature review provides a limited summarized resource of ubiquitous computing but many systems developments and implementations are not published in the literature. Therefore, this article does not fully cover the field of ubiquitous and pervasive computing.

3. Ubiquitous Computing Technologies

This section briefly discusses some of the important ubiquitous technologies that are considered to be the vital components of any business process. Three ubicomp technologies have a direct and strong impact on business processes. Automatic identification, localization, and sensor technology provide the means to answer questions like: "Where is which product, what its current state is and what products are in its neighborhood?" (Strassner & Schoch, 2002). Business processes are revolutionalized by Automatic Identification Technologies (AIT). It is a technology that is commonly used to identify products or delivery units.

Automatic Identification

Auto-ID systems are barcode, RFID, smart card, and biometric systems. Two tasks are common in the identification process for every Auto-ID system: capturing an external signal from the entity that should be identified (e.g. capturing the image of a barcode) and recognizing that signal by a computer analysis (e.g. retrieving the encoded information) (Strassner & Schoch, 2002). Bar coded is often regarded as the "Optical Morse Code". The barcode systems are the most intensively used form of Auto-ID technology in every industry worldwide for object recognition. Bar codes are industry specific and uniquely identified by its symbology. Products typically have either one-dimensional barcodes with limited data up to 10 bytes or two-dimensional barcodes that can contain more data up to 1000 bytes. In a typical business setting bar code assists in accurately identifying raw materials, tracking work in process, managing inventory, directing shipments, and providing lifetime identification for service and warranty management (Barcoding Incorporation, 2012). Radio Frequency Identification (RFID) offers more data capacity than a linear barcode since it uses radio waves for identification instead of an image or pattern. RFID reader can read invisible small chips (tags) attached to entities that store the identifier (Efficient Business Systems, 2014). An antenna is connected to the chip so that if the tag is within the read range of an RFID reader, the identifier can be read out without the need of line of sight. Active solutions have their own energy supply integrated into the tag, which enables them to transmit their identifier up to 100m. In contrast, passive solutions are typically able to transmit their identifier up to 2m. The emerging RFID systems are a good alternative to barcode systems, since they do not need human intervention and do not need line of sight between the tag and the reader (Finkenzeller, 1999). RFID technology works best for the purpose of tracking multiple objects and offers several advantages over bar coding.

Magnetic stripe is another very common form of automatic identification technology. It is a hardware that decodes the encoded personal information housed in a magnetic stripe on the back of the plastic card. However, this technology is being phased out to the adoption of newer and smarter smart card technology.

Smart Card is also a plastic card that contains an embedded integrated circuit chip (ICC) or a micro controller chip. These cards are more secure and hold lot more information than magnetic stripe card and are capable to perform encryption and mutual authentication procedures. They are used in variety of applications worldwide in the form of payment applications, telecommunication applications, secure identity applications, and healthcare applications. There are two general categories of smarts cards available today: contact and contactless.

Biometrics Technology is a revolutionary deployment of automatic identification technology that is being implemented worldwide. This technology is believed to be the most secure and authentic form of Automatic Identification Technology (AIT). It is used to uniquely identify and authorize an individual's access to a computer or physical location using distinguishing biological traits. (BBC) It uniquely identifies a persons' profile and behavioral characteristics (fingerprints, hand geometry, earlobe geometry, retina and iris patterns, voice waves, DNA, and signatures). This technology is in high demand to match concerns over international, business and personal security.

Localization

(Guoqiang, Baris, & Brian B.O, 2007) Wireless sensor networks (WSNs) are a significant technology attracting considerable research interest. Recent advances in wireless communications and electronics have enabled the development of low-cost, low-power and multi-functional sensors that are small in size and communicate in short distances. Cheap, smart sensors, networked through wireless links and deployed in large numbers, provide unprecedented opportunities for monitoring and controlling homes, cities, and the environment. In addition, networked sensors have a broad spectrum of applications in the defense area, generating new capabilities for reconnaissance and surveillance as well as other tactical applications (Chong & Kumar, 2003) Localization in general, (Hightower & Borriello, 2001), is combined with automatic identification, since the sole location information is often useless without the identity of the located entity (Strassner & Schoch, 2002). In simple words it is the process of identifying physical location of sensor nodes. There are several techniques that complement localization. We briefly discuss a few of them. The simple of all the localization techniques is proximity based localization in wireless sensor networks (WSNs). If an entity can be recognized within a cell, such a system can determine that the entity must be in the proximity of the known position of the monitoring device. Proximity can also be derived from other Auto-ID systems. For instance, if a smart card is recognized with the last know location the smart card owner's location is identified at that particular location at that point in time (Strassner & Schoch, 2002). (Brida, Duha, & Krasnovsky, 2007) Argue that proximity based localization belongs to the group of range-free localization. Localization using proximity measurements is popular, when low cost takes precedence in priority over accuracy. Since, messages necessarily pass between neighbors, there is no additional bandwidth required to proximity. Proximity measurements simply report whether or not two devices are 'connected' or 'in-range' and determines whether an object is near one or more known locations.

(Song, Haas, & Caldan, 2007) Triangulation involves computing the position of an object by measuring its distance from multiple reference points with known locations. Depending on whether ranges or angles relative to reference points are being inferred, triangulation is divisible into lateration and angulation. Lateration can be further classified into the time of flight (TOF) and received signal strength (RSS) methods, where the ranges to reference points are inferred from time of flight and signal strength of the communication signal (e.g., ultrasound, laser, RF), respectively. The TOF based localization systems like GPS requires clocks with high resolution to deal with the problem known as time synchronization.

The scene analysis technique infers the location of objects using features of a scene observed, such as visual images, which do not correspond to geometric distances or angles. The useful features of a scene also include electromagnetic signal characteristics that occur when a signal transmitter is at a particular location. Such signal characteristics can serve as "RF signature" unique to a given location, but the major drawback of this technique is the extensive effort needed to generate the signal signature database and reconstruct the predefined database with significant changes in the environment leading to less than accurate results. (Hightower & Borriello, 2001), (Bulusu, Heidemann, & Estrin, 2000), (Song, Haas, & Caldan, 2007). However, both scene analysis and triangulation techniques actually measure the object's distance to reference points.

The Global Positioning System (GPS) is the only system that is widely used today which uses the lateration technique with one GPS receiver and 4 visible GPS satellites. It can be used to precisely track the location of objects over a range of geographic and geometric scales. Unfortunately, this technology is limited for outdoor use and comprehensive object tracking is not viable.

Sensor Technology

The unprecedented growth in electronic products and services led to the development of sensors to work in different working environments. The sensor technology permeated into a variety of domains environment, medicine, commerce and industry. (Strassner & Schoch, 2002) Different sensor types include thermal, acoustic, visual, infrared, magnetic, seismic or radar sensors to monitor conditions like temperature, humidity, vehicular movement, lightning conditions, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects or current characteristics such as speed, direction, and size of an object. Technical advances in MEMS (micro electro mechanical systems), which deals with machines in the nanometre scale, also influences the design of new sensors that are getting smaller in size and consume less energy.

Current research in sensor technology focuses on a broader issue: wireless sensor networks (Akyildiz, Su, Sankarasubramaniam, & Cyairci, 2002). The innovations are the networking capabilities of sensors, which allow the network to benefit from being autonomous since they are no longer directly connected to a central controlling computer, from utilization in remote and unknown regions, and from synergy effects through collaboration (Strassner & Schoch, 2002). (Ley, 2007) Having an identity and location information enables a variety of applications and uses, but adding a sensing capability can give systems 'eyes and ears' creating intelligent networks that can collect a range of data and even respond to events. Installing sensors on RFID tags or wireless network nodes enhance operating capability of ubiquitous networks to manifold level. Hence, network responds to ever changing environment independently without any human intervention.

MEMS

(Ley, 2007) Micro Electro-mechanical Systems (MEMS) are moving parts on chips that are used to sense the environment and potentially to initiate an action, allowing systems to respond to the real world around them. Today MEMS are already being used in cars to detect collisions and deploy airbags. Inertia sensors have been embedded in some mobile phones and games controllers (such as the Nintendo Wii) to allow users to interact with the device through movement.

The development of tiny sensor nodes "smart dust" networks potentially the size of a grain of rice also known as motes, smart dust, and speckles are very robust and can be scattered or sprayed into an environment or on an object. These systems, however, are still very much in research and development stage around the world.

The Learning Systems: Context Awareness

As Mark Weiser said "Ubiquitous Computing is a technology that resides in the human world and weaves itself into the fabric of everyday life", it is also the main objective of ubiquitous computing to make the information available on demand in real time situation. The sensor technology is smart enough to identify the exact location and time to precisely provide all the information about the object at a give point in time. This involves multi sensors that enable the learning systems to be able to adapt from the range of unique characteristics. Context- aware systems should help filter information and make IT work for us without us having to actively interrogate systems. This allows learners to concentrate on the task rather than the technology (Ley, 2007).

The intelligent agents are highly engineered and smart software tools that execute actions based on the range of data from multiple sources. These are autonomous and self decision making systems that learn from experiences based on the serious of events and intelligently respond to the situations. A classic example is that of smart thermostats that controls temperatures according to our preferences. It learns from our demands of temperature requirements and adjusts the temperature changes accordingly. (Ley, 2007) This allows systems to become much more human/learner centered. The systems and devices are now becoming increasing pervasive to respond to our social and emotional activities.

4. Diversified Impacts of Ubiquitous Computing

Ubiquitous systems have the challenge of implicitly collect relevant information about entities, and use this information to understand and predict their behavior. This allows the applications to adapt themselves to the entities, thus avoiding to overflow them with inquires and information (Wagner, Barbosa, & Barbosa, 2013). The analysis of trails, the context-aware history of actions, can further improve the relevance of information.

Ubiquitous computing technologies can be leveraged in disseminating knowledge and learning in higher education setting. Human computer interface is already pervasive with the existence of smart gadgets and wireless technologies supported by numerous technologies and applications. In an education setting, teachers, students, educators, and curriculum developers combined with ubiquitous devices can take the learning to the next level (Norris & Soloway, 2008) "mobile 21st-century tools for 21st-century learners". U-learning is the superset of e-learning and m-learning. U-learning is essentially the integration of both e-learning and m-learning but extends to pervasive learning environment by incorporation of ubiquitous devices supported by mobile and ubiquitous computing technologies including mobile devices such as embedded computer devices such as GPS, RFID tags and sensors, pads, and badges, and wireless sensor networks. In other words (Marinagi, Skourlas, & Belsis, Employing ubiquitous computing devices and technologies in the higher education classroom of the future, 2013) ubiquitous learning environments, equipped with ubiquitous devices and exploiting ubiquitous technologies can encourage student's involvement in the learning process, without requiring student's active attention. U-learning can relate learning to the learner's situation and increase effectiveness and efficiency of education system.

Ubiquitous devices are playing a vital role in the domain of logistics. With the creation of "Internet of Things" that globally interconnects smart devices and sensors networks, ubiquitous technologies, wireless communication, and passive or semi-passive RFID are playing an important role in logistics including shipment and transport management. Railways use RFID & GPS technologies to track each freight car across continental United States. RFIDs are playing a vital role in retailing. The RFID transponders attached to objects makes it very easy to identify goods at a given time along supply chain which can further assist in managing inventory and forecasting demand and supply. Radio based technologies in addition to being costly; however come with a major disadvantage of security and privacy. **Table 1**, illustrates a quick snapshot of history and ubiquitous computing.

Table 1. History of Ubiquitous Computing at a Glance

History	Principles	Challenges	Future Trends
• Concept coined by Mark Weiser, Chief Technologist Xerox PARC • Initiated a Ubiquitous Computing Project in 1988 • Mark Weiser's Vision: *"….highest ideal is to make a computer so embedded, so fitting, so natural, that we used it even without thinking about it"* • Computers everywhere, disappearing/ integrated in environment/objects around us • Computer no longer isolates us from tasks/ environment, no longer focus of attention • Social impact: similar to writing: Omnipresent • Similar to electricity: flows invisibly everywhere	"… 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." • Calm Computing • Ambient Intelligence • Mobile / Wireless computing • Hands-free UI / Intelligent environment • Disaggregated computing / Migrating UI • Location-sensitive data & services • Invisible computing • Wearable computing	**Privacy Issues:** The protection of personal information is a major issue as a result of pervasive computing. Smart and cooperative ubiquitous computing devices today and in the future will be more obtrusive and more in real time control. People will interact with them in real time everywhere transmitting real information about location, movement, intent or even identification. Potential risk of uncontrolled flow of sensitive data and information. **Localized Scalability Security:** As networked computer systems become more deeply embedded the type of damage can be more varied and more pervasive. Computing infrastructure and service delivery methods will need to be more tightly integrated.	• Human-Computer interaction will more humanized • Networks will be more embedded and ubiquitous • Devices will be smarter and have capability to think • Cities will be more ubiquitous , u-city • Homes will be smarter: • Sensors and RFIDs will evolve into more complex devices. Sensors like SMART glasses, e-Nose already exist. • Convergence of computing capabilities onto smart phones. **Advanced:** • Awareness Modeling Systems • Business Environment • Education Environment • Human-Computer interaction will more humanized • Networks will be more embedded and ubiquitous • Devices will be smarter and have capability to think

These systems are vulnerable to hacking since this technology works over wireless communication. Pervasive computing, ubiquitous computing, and ambient intelligence have deeply influenced healthcare industry. It is often thought to supplement the existing information systems. The industry is set to improve healthcare by inheriting ubiquitous characteristics of systems and devices. The pervasive computing can have possible applications in diagnostic, therapeutic, nursing and documenting functions. Remote, automated patient monitoring and diagnosis, may make pervasive computing a tool advancing the shift towards home care, and may enhance patient self-care and independent living. Automatic documentation of activities, process control or the right information in specific work situations as supplied by pervasive computing are expected to increase the effectiveness as well as efficiency of health care providers. For example, in hospitals pervasive computing has the potential to mobility: Application areas that are characterized by mobility and rapidly shifting contexts have typically appeared as strong cases for context-aware and ubiquitous computing. Context-aware and ubiquitous computing in general build on the premise of changing use situations, and mobility is often the cause of such change, (2) interuptiveness: The hospital work environment is highly dynamic and interruptive in nature (Coiera & Tombs, 1998). Due to sudden and often unpredicted events healthcare personnel often need to reorder their work priorities. As a consequence, their moment-by-moment activities are typically equivalent to those that have been given the highest priority, (3) situational awareness: Issues like extensive mobility and suddenly occurring events, make conventional desktop computer interaction inappropriate for hospital workers. Another aspect that contributes to this is the inadequacy of stationary computers to allow hospital workers to keep their primary attention on the care situation and on the patients., and (4) temporality: Hospital wards are highly distributed work environments, not only in the sense that caregivers often are spatially separated due to their constant mobility, but also in the sense that hospital work is distributed in time. The latter is a result of rotating shifts but also a consequence of changing work priorities causing unfinished tasks of less priority to be temporarily postponed.

(Friedewald & Raabe, 2010) (Joseph, 2006) The use of ubiquitous computing in the area mobility and transport is regarded as a basis for a new generation of strongly networked and integrated systems to control transport flows and to inform road-users. The starting point here are solutions such as electronic tickets based on RFID or near-field communication, navigation and traffic recording systems as well as the traditional traffic telematics, which are currently being supplemented by so-called “vehicular ad hoc networks”.

Table 2, illustrates ubiquitous technologies relationships.

Table 2. Ubiquitous Technologies Relationships

	Mobility	Embeddedness	Ad hoc Networks	Context Awareness	Energy Autarky	Autonomy
Communication Technology	√		√		√	√
Human- Machine Interface		√		√		√
Inter-Machine Communication		√	√	√		√
Localization Technology	√			√		√
Microelectronics	√	√				
Power Management	√		√		√	√
Security Technology		√	√	√		
Sensor Technology			√		√	√

Adapted from: Ubiquitous Computing: Applications, Challenges and Future Trends, Jaydeep Sen (Academic.edu)

5. Ubiquitous Computing in its Current Phase

In order for ubiquitous computing to become a major dominating and pervasive computing trend, this technology has a lot to accomplish. Research and developments are ongoing efforts to reach to that state. Weiser’s vision of pervasive computing focused on its key characteristics. He envisioned a combination of technology, hardware, and software to be intercommunicating continuously to define his concept of ubiquitous and pervasive computing. Thus, power consumption, user interfaces, wireless technology, and associated costs come into limelight to justify a result oriented functioning of ubicomps.

The most important of all is the power consumption of devices since the devices have to operate uninterrupted regardless of position or location. They have to be energy efficient and operate on low power consumption at all times for longer than normal periods and be online in the event of power cut from main supply.

In a typical ubiquitous environment, all the devices are required to remain connected with one another and continuously exchange information or talk. Wireless technology is the only enabler for such a type of communication since most of the ubicomps are embedded in other devices and their functionality is interdependent on other devices. Wireless technology was always a concern of ubiquitous computing. Weiser wanted to see several types of wireless connections implemented on ubiquitous computers (Weiser, 1991):“Present technologies would require a mobile device to have three different network connections: tiny range wireless, long range wireless and very high speed wired. A single kind of network connection that can somehow serve all three functions has yet to be invented.”

(Schomburg) There is still not a do it all connection; however, wireless connectivity is common place through standards like 802.11b/n/g and short range standards like IrDA or Bluetooth are being used today. Weiser also addressed the problem with mobile IP addresses and assignment related to networking. It is not completely logical to assume that computers can have a static constant IP that defines them upon a give network since computers will not always remain on the same network. A business man may travel from New York to Hong Kong in a day, and every ubiquitous device he carries with him would as well. The problem is how to change the routing information so that his devices still work properly. In addition, if ubiquitous computing were ever implemented on a larger scale, more IP addresses would be needed. If every home appliance in every house had an IP address there would be an issue of running out of addresses. Since Weiser wrote his paper in ’94, IPv6 has been developed and addresses or solves many of these issues (Schomburg).

If ubiquitous computing is going to be achieved, cost becomes an important factor because these machines will need to be pervasive; therefore, it is not practical to assume people will be willing to pay high prices for the multitude of ubiquitous computers which are in place in everyday life. Thus, ubiquitous computing has to take cost into consideration and be innovative in producing cost effective solutions (Schomburg).

6. Pros of Ubiquitous Computing

Mark Weiser’s vision of indistinguishable computing devices to operate invisibly blended with the environment has become a reality and in some ways indispensible. Pervasive computing and the Internet of Things are still visionary things before we would use them at their full potential. However, this technology has come with a price. In general there are concerns about the invasion of privacy, trust and the security of systems. There is definitely a need to move with the idea of privacy. Further it is believed that ubiquitous computing produces humongous amounts of complex data that impacts the technology itself to cope with it resulting in compromising with the reliability and dependability of the systems. Hence, there are a lot of efforts required to address the development of hardware, interfaces, system architectures, standards for interoperability and battery life. Ubiquitous computing, however, poses many challenges related to security of the information being transmitted between users and devices. There are risks of classified information being accessed by unintended and malicious users in pervasive environment which can be misused for unlawful purposes. (Ley, 2007) points out if the computational system is invisible as well as extensive, it becomes hard to know what is controlling what, what is connected to what, where information is flowing, how it is being used, what is broken (vs. what is working correctly, but not helpfully), and what are the consequences of any given action (including simply walking into a room). (Ley, 2007) Even now, people can be tracked through their mobile phones, credit/loyalty cards, and CCTV, but the convenience and benefits of these technologies are often seen as outweighing the concerns. Nevertheless, given the cost-benefit ratio of this new paradigm in computing, ubiquitous computing will dominate and be realistic in the very near future.

7. Conclusion

Dependability and reliability of ubiquitous computing and systems will always be a big question along with its social impact and desirability of such pervasive technologies. Ubicomp technology enables a large number of new applications having impact on business processes. Many application areas and scenarios include healthcare, logistics, production, and supply chain that is technically feasible and beneficial, mainly based on automatic identification, sensor technology, and localization.

(Friedewald & Raabe, 2010) Ubiquitous computing and its various applications present a considerable challenge for the further development of data and consumer protection. The legal challenges are in the protection of users’ informational self-determination in relation to the legally protected business interests of the operators of UbiComp applications. In addition, questions may arise from the expected utilization of autonomous information systems under private law. On the other hand it has a lot to offer in terms of benefits. It can potentially address the issues of digital divide, ageing population and encourage life-long learning. Furthermore, these technologies are likely to develop rapidly over time and we will witness greater increase in the adoption of ubiquitous computing. In the future these technologies will make more presence in enabling and integrating human computer interaction and context-based learning where natural interactions take place between people, systems, places and objects. These are beginning to allow new interactions and ways of interfacing with computer systems, as well as adding new intelligence to systems. This paper briefly focused on applications that can be realized with today's technology and have positive business impacts and identified great potential that of ubicomp technologies will increase in the future. These technologies have had a phenomenal impact on our everyday life; however it also shows that privacy issues cannot be disregarded and poses a challenge on protecting it.

(Abowd & Mynatt, 2000) The real goal for Ubicomp is to provide many single-activity interactions that together promote a unified and continuous interaction between humans and computational services. The focus for the human at any one time is not a single interface to accomplish some task. Rather, the interaction is more free-flowing and integrative, akin to our interaction with the rich physical world of people, places and objects in our everyday lives.

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