A Theoretical Framework for Ubiquitous Computing

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ABSTRACT
You may forget where you left your keys when you need them. In ubiquitous computing space your keys will find you and inform you where they are. Ubiquitous computing, the third generation of computing spaces, following mainframes and personal computers, is in its incipient evolution steps. In ubiquitous computing space, sensors and computing nodes are invisibly, inconspicuously, and overwhelmingly embedded in all real-world objects and are all connected to each other through omnipresent wireless networks. The goal is to make real-world objects seem intelligent and autonomous in providing users with electronic and Internet services with users not even noticing how they are provided with these services. The real world, cyberspace, modeling, and mathematics are identified as the main constituents of ubiquitous computing in this study. These four areas are investigated one-by-one and in combination to show how they create a solid foundation for ubiquitous computing. An application of ubiquitous computing in car navigation systems is used to indicate the reliability of the proposed framework.

KEYWORDS
Cyberspace, Mathematics, Modeling, Pervasive Computing, Real World, Ubiquitous Computing

1. INTRODUCTION
Ubiquitous computing, also referred to as pervasive computing (Scholtz & Consolvo, 2004) or calm technology (Greenfield, 2010), is a multi-disciplinary field, bringing together a wide range of information, technology, and science where they all collaborate to reach a common goal (Bell & Dourish, 2007): accessing computing resources at any time and location by anyone, without them directly providing input or interpreting the output. In ubiquitous computing an individual may continually interact with several interconnected sensors and computers, nearby or faraway, to receive a service (Araya, 1995). However, all hardware and computations are hidden and invisible to users (Lyytinen et al., 2004), making it look like people are interacting/communicating with their surrounding objects not computers. This vision was first posed by Weiser (Weiser, 1991) as the third generation of computing spaces.

Figure 1 shows different generations of computing spaces: mainframes, personal computers, and ubiquitous computing. UNIVAC is the first commercial computer developed in 1951. It included
a large cabinet called mainframe maintaining the main processor and memory (Henderson, 2009). Mainframes introduced large powerful computers with a lot of memory accessed by many people at the same time (Christ, 2015). IBM dominated this market with its mainframes-IBM 360 and 370 since early 1860s until late 1970s (Rhoades, et al., 1979).

Mainframes were not accessible to everyone but large organizations capable of affording their expensive prices. Besides, these mainframes were not easy to work with, requiring well-trained practitioners (King, 1983).

The advent of microprocessors in late 1970s (Isaacson et al., 1978) made it possible to manufacture personal computers with more affordable prices for public. This invention also pinpointed the beginning of the second generation of computing spaces called personal computing where everyone could have several personal computers at home, work, or in their pocket (Guimaraes & Ramanujam, 1986). The emergence of Internet in 1969 from ARPANET project (Leiner et al., 2009) made it feasible to interconnect personal computers and mainframes and to transfer digital data across the world. Personal computers and Internet remarkably influenced businesses, markets, and different scientific and engineering fields and paved their progress path. Cyberspace was introduced in this generation with computers as its gates to the real world. The outbreak of mobile technology and wireless Internet in 20th century marked the pick of this computing generation where people could connect to cyberspace and transfer data using their mobile devices anywhere and anytime (Dinh, et al., 2013).

Increasing the number of computing devices, memory capacities, and Internet bandwidths and enhancing processing capabilities and display qualities are no longer the first priority of computing companies (Weiser, 1993). The focus has shifted from computers to tasks that people use computers for; from technology to activity (Kinsley, 2011); from syntax to semantics. The third generation of computing spaces attempts not to distract people from their tasks by clutters of gadgets, buttons, batteries, remote controls, cables, connectors, and passwords (Hawley, et al., 1997).

Ubiquitous computing, the third in this trend, reverses the flow and lets computers share people. Countless computers will surround people invisibly, being embedded in their coffee mugs, raincoats, chairs, wallpapers, and everything (Greenfield, 2010) not just their mobile phones and personal computers. We have already witnessed the evolution of ubiquitous versions of writing and electricity
Model and Ontology-Based Development of Smart Space Applications
www.igi-global.com/chapter/model-ontology-based-development-smart/53787?camid=4v1a

JAVA Jigsaw Puzzle
www.igi-global.com/article/java-jigsaw-puzzle/187090?camid=4v1a