CHAPTER 1
Introduction

1.1 Ubiquitous e-Service Today

The Internet has introduced a significant wave of change in communication patterns around the world. People interact with friends through email; connect to firms through their web site. E-services have appeared on the Internet in the form of e-business sites and portal sites. Such e-services are capable of intelligent interaction and are able to discover and negotiate with each other, mediate on behalf of their users and reconfigure themselves into more complex services. These new configurations may be static or dynamic.

Many Mobile users access one or more e-services for performing desired tasks. Accessing e-services through mobile devices is often termed m-commerce (as opposed to e-commerce, which assumes e-services being accessed by static users). The term “ubiquitous commerce” is used to denote ubiquitous networks created to support personalized and uninterrupted communications and transactions between a firm and its various stakeholders to provide a level of value over, above, and beyond traditional commerce. (Watson, Pitt, Berthon, & Zinkhan, 2002)

Mobile commerce promises to deliver the real potential of Internet for commercial purposes to a significantly expanded market of existing and new users. A four-level integrated mobile commerce framework has been proposed (Varshney & Vetter, 2002), that discusses how to successfully define, construct, and implement the necessary hardware/software infrastructures in support of mobile commerce. Wireless technology and mobile networks make it possible for mobile users to connect to the Internet, and mobile-service applications have become popular. With the appearance and penetration of mobile devices such as notebooks, PDAs, and smart phones, pervasive (or ubiquitous) systems are becoming increasingly popular these days.

Examples of mobile commerce applications include: mobile financial applications such as m-banking, m-brokerage services that allow the mobile device to become the financial medium, mobile advertising applications that attempt to transform the wireless environment into a new marketing battlefield, and mobile shopping services. In other
words, mobile commerce has ushered in a slew of new opportunities and new applications in e-commerce and e-business.

However, the applications reviewed in Varshney & Vetter (2002) were grounded in the client/server architecture where the only interactions involved are between a services provider and a mobile user, and did not including possible interactions between the mobile user and the environment or other nearby mobile users.

1.1.1 Two Different Design Paradigms (Client/Server vs. P2P)

Although mobile commerce grown in a remarkable fashion, most existing mobile services and applications were designed based on client/server architecture. In the foundational mobile commerce framework, service consumers request service providers for mobile services, and requested service items are then delivered to mobile users via GSM or similar wireless networks.

In the foundational mobile commerce framework, mobile users were essentially standalone users due to the lack of technology functions and communication channels that enabled mobile users to interact with each other. Interactions between mobile users were not considered an important issue in mobile service scenarios. Consequently, the collective value generated from a peer group of mobile users (or multiple peer groups) cannot be realized.

The latest Peer-to-Peer (P2P) technology (e.g., JXTA) enables mobile e-services to take the next step. This technology makes it possible for individual mobile peers to communicate with each other and wirelessly exchange information under sensor-enabled environments. Collaborative interactions between mobile users create a new paradigm for mobile telecommunications. This new framework for mobile applications, its dynamic environments, and the collective efforts of mobile users, are deserving of investigation.

1.1.2 From P2P to Ambient e-service

P2P computing has increasingly emerged at the forefront of Internet computing. A concept involving cooperative computing and resource sharing (i.e., collective efforts), t has been around for quite a while (Kant, Iyer, & Tewari, 2002). P2P has opened up possibilities of very flexible web-based information sharing based on the fixed Internet foundation. Applying the notion of P2P to mobile environments, mobile P2P (M-P2P) seeks to enable the power of collective effort in the mobile world. Supporters argue that
mobile users can exchange their own experiences, eliminating the digital divide. That is, collaboration between mobile users better empowers a mobile user than the situation where the user is standalone.

On the other hand, ambient intelligence refers to the vision that technologies become invisible, embedded in our natural surroundings, present whenever we need them, enabled by simple and effortless interactions attuned to all our senses, adaptive to users and context and autonomous acting (Lindwer et al., 2003). In other words, ambient intelligence embeds information representation in everyday objects (lights, pens, watches, walls and wearable, etc.), making the physical environment an interface with the digital one. In this paper, we envision this idea as mobile e-services built with the M-P2P technology, exploiting the idea of ambient e-services.

Prior to any attempt to define ambient e-services, location-based services (LBS) in mobile commerce require definition. Location-based services employ knowledge of the user's location to enable the provision of new or enhanced services to a user via a wireless handheld device (such as a mobile phone or PDA). LBS capitalizes on surrounding contexts to provide enhanced user experience and giving location-based experience sharing as well as receiving (Lim & Saiu, 2003). Context is the set of environmental states and settings that either determines an application’s behavior or in which an application event occurs and is interesting to the user.

Wireless e-services can potentially be personal, timely and relevant, or even integrated with other services in a near-seamless way (Katz-Stone, 2001). Within ambient environments, wireless handheld devices are personal to a user and carried by the person; the context of the user (e.g., time and place) can be measured and interpreted; services can be provided at the point of need; and applications can be highly interactive, portable and engaging. The key to wireless e-service is the moment of value -- according to the dynamic surrounding environment, is this moment the correct moment for what the user is trying to do?

1.1.3 Beyond Sensor Network: The Power of Social Context

Can current sensor networks be replaced by ambient e-services? In recent years, sensor research has been undergoing a quiet revolution that promises to have significant impacts on a broad range of applications relating to national security, health care, the environment, energy, food safety, and manufacturing. Wireless Integrated Network Sensors (WINS) provide distributed network and Internet access to sensors, controls, and processors that are deeply embedded in equipment, facilities, and the environment.
WINS combine micro-sensor technology, low power signal processing, low power computation, and low power, and low cost wireless networking capability, in a compact system. WINS networks will provide sensing, local control, and embedded intelligent systems in structures, materials, and environments.

Ambient e-services go a step further than sensor network environments. In a sensor network environment, peers within the range may not know who other peers are (i.e., social context is confidential and presumed to be retained privately). But ambient e-services are capable of leveraging the private social context of peers or past interactive experience, diversifying the potential opportunities for dynamic collective effort. For instance, mobile users may exchange their own experiences of certain items in a shopping mall. Social connections between mobile users, collaborative relationships and the trust or reputation basis for mobile user interactions cannot be realized in a sensor network environment.

In short, there are two distinguishing characteristics that make the P2P design more appropriate for ambient e-services than client/service architecture. Social connections based on the context aware environment provide trustworthy linkages, while keeping sensitive data from others. How is sensitive data handled? The social context is retained solely in the personal devices. Otherwise, the prospect of seeing their sensitive data stored in a central server will make users less willing to participate in such services. Further, by comparison with client/server architecture, P2P design makes the connection numbers grow in rapid progression, especially in an open space. This diversifies information source heterogeneity.

1.2 Trust in Ubiquitous Environment

The ongoing, rapid developments in information systems technologies and networking have generated significant opportunities for streamlining decision-making processes and maximizing productivity through distributed collaborations that facilitate unprecedented levels of sharing of information and computational resources. Emerging collaborative environments need to provide efficient support for seamless integration of heterogeneous technologies such as mobile devices and infrastructures, web services, grid computing systems, various operating environments, and diverse products. Such heterogeneity introduces, however, significant security and privacy challenges for distributed collaborative applications. Balancing the competing goals of collaboration and security is difficult because interaction in collaborative systems is targeted towards
making people, information, and resources available to all who need it whereas information security seeks to ensure the availability, confidentiality, and integrity of these elements while providing it only to those with proper trustworthiness. Hence, ensuring trust in an ubiquitous environment is one of the most important tasks of the new networking paradigm.

The ubiquitous environment is different from a traditional static environment. It presents significant challenges for users in determining which users are trustworthy, since information is seldom available, and previous solutions may not be applicable to the ubiquitous environment. Environmental constraints and computational limitations make it more difficult to execute the process for determining which users are worthy of trust. There is no centralized or trusted 3rd party/agency to manage that task, and guarantee the trustworthiness of each identity. These new challenges complicate trust determination. Environmental limitations and challenges will be discussed in more detail in Chapter 2~4.

Since the ubiquitous e-service is highly correlated to user’s current position, if the invasion of privacy is considered risky by users, users may resist the potential benefits of e-service. Since identities are short-lived, historical records may not be available. Therefore, in an ad-hoc e-service environment that changes identity rapidly, there little information available for others to determine whether users should be trusted. Without a trustworthy mechanism that can support user privacy protection and maintain transaction security, e-services may not attract enough participants to encourage e-services providers to enhance their service quality. By the same token, once the user perceives they are well protected from possible fraud or malicious transactions, the benefits of various e-service applications will increase significantly.

To solve the problem of creating trust in the ubiquitous environment, we propose an autonomous trust model for exploring the collective wisdom in the ubiquitous environment, called “U-ATM”. Similar to the Automated Teller Machine (ATM) that has widespread use in the banking industry, the U-ATM allows users to choose trustworthy partners for executing transactions in the risky ubiquitous environment. U-ATM design integrates the concept of privacy protection, reputation management, and trust estimation in the ubiquitous environment. U-ATM design is proposed to provide a feasible solution for quality decisions in the dynamic and distributed environment in which identities are short-lived and the computational abilities of mobile devices are limited.

In the U-ATM design, we utilize the major benefit of ambient e-service, focusing
on combining the collective strength of users to construct a transaction environment that respects security and privacy and takes advantage of the convenience of various ubiquitous e-service applications. The U-ATM design and method evaluations will be elaborated in the Chapter 5~8. In Chapter 9, we present the theoretical support of proximity value. Finally, the vision of U-ATM, comparable existing works and conclusions are arranged in Chapter 10.

1.3 Dissertation Roadmap

The dissertation roadmap planning is shown as Figure 1-1. This dissertation consists of 10 Chapters organized into two major parts: (a) ambient e-service and (b) U-ATM.

The major element, ambient e-service, is depicted in Figure 1-2. It includes (a) the Ambient e-service framework; (b) ambient e-service application scenarios, (c) issues and challenges of ambient e-service; (d) privacy, reputation and trust for ambient e-service; (e) ambient e-Service Embracing Model (ASEM); and, (f) Roadmaps and mega values for ambient e-service.
The U-ATM is based on ambient e-service, and enables the collective wisdom of the ubiquitous environment. Three key elements contribute to the U-ATM design: the privacy design, the reputation management design, and the trust management design. These three parts are closely related to one other, and are integrated as a whole mechanism to support users in their explorations of the ubiquitous environment. As shown in Figure 1-3, the U-ATM works not only with the three key elements, but also merges into the pervasive computation environment. Based upon the IEEE 802.15.4 and ZigBee architecture, ambient e-service makes collaboration between nearby users both
possible and powerful, especially for trust estimation. The U-ATM also meets the challenges from heterogeneous data sources, seamless unlinkability management and convenient data access control, as well as dynamic identity management, for the ambient environment.

Several publications have originated from this dissertation. At the Fourth International Conference of Electronic Business (ICEB2004) (Hwang & Yuan, 2004), we proposed the ambient e-service framework and various application scenarios. At the Second IEEE International Workshop on Mobile Commerce and Services (WMCS05)(Hwang & Yuan, 2005b), we proposed the ambient e-service embracing model. At the 7th International IEEE Conference on E-Commerce Technology (CEC05)(Hwang & Yuan, 2005a), we proposed the framework design and measurement design of the ASEM. After winning the best paper award at Changgung University in 2005, we submitted our paper on the roadmap of ambient e-service to the International Journal of Electronic Business Research. It will be published in 2007 (Hwang & Yuan, 2007). Advanced U-ATM designs have been submitted to international conferences and journals, but currently are under review.