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Applying Ubiquitous Computing Technology to Proactive and Personalized Decision Support System

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Abstract

This paper aims to describe how the decision making capability and context-aware computing are jointly used to establish ubiquitous applications. An amended DSS paradigm: CKDDM is proposed in this paper. Under the CKDDM paradigm, a framework of ubiquitous decision support systems (ubiDSS) is addressed with the description of the subsystems within.

1. Introduction

Nowadays, information technology environment has been changing so fast. As opposed to the mainframe data processing model of the 1970s and the PC-based end-user computing model of the 1980s, the Internet and the global Web have provided opportunities for developing new business models. The Web has made the need for decision support ever more pronounced because of the vast amount of business information made available by the global Web, which helps bring together the information passed between businesses, between a business and its customer, and among different departments of a business. We are entering a new era of enterprise computing characterized by an emphasis on networking, knowledge sharing, and channel integration. Some people refer to this as the 'ubiquitous network' business model for its focusing on a high degree of connectivity between a company and its customers, suppliers, and channel partners. As we enter into this new era, it is imperative that researchers in the decision support systems field consider this new paradigm. [Shaw et al., 1997].

Meanwhile, ubiquitous computing environment is now emerging as a main engine to change the task environment of the decision makers, and to reshape the new era on the way we do business. This trend with no doubt has the potential to improve the framework of decision making.

Hence, this paper aims to identify what needs to be considered for the future decision support systems when we regard ubiquitous computing technology as an inevitable impact which enforces the change of the way of making decisions. A framework of ubiquitous decision support systems (ubiDSS) is addressed with the description of the subsystems within.

2. On-going ubiquitous computing research projects

On-going ubiquitous computing-related research

projects can be categorized into 5 thrusts; U-Device, U-Environment, U-Media, and U-People, as listed in Table 1.

Despite of its infancy, in summary, ubiquitous computing technology has a plenty of possibilities to get applied in providing innovative computer-based information systems such as DSS that enables more personalized and agile services. Some concepts and artifacts of ubiquitous computing can leverage several functions of traditional computer-based information systems. Especially, as the information systems get more intelligent aspects, agile acquisition of knowledge and expertise from domain experts becomes more important to provide employees and decision makers with relevant know-how. Therefore ubiquitous computing technology for identifying user's context and mining recommendations from it are quite tailored to the current intelligent information systems. However, this thrust of research has not much progressed, because most of practitioners in the field of information systems have just interested in the subjects causing quick returns. In other words, although rooms for improvement of conventional information systems were exhibited, practitioners usually have tried to develop new kinds of information systems substituting the old ones because they regarded the substitution as the only way to earn larger profit. However, deploying the technology from ubiquitous computing and enhancing functions of information systems not only guarantee the larger profit through higher efficiency, but also support the business activities with higher effectiveness.

<Table 1> Ubiquitous computing research

	Overview	Research
U-Device	Devices for identifying users' context	Active Badge[Want et al., 1992], e-Gadgets[Hagras et al., 2001], Smart-Its[Holmquist et al., 2001], PARCTAB[Schilit et al., 1993], Smart Dust[Kahn et al., 1999]
U-Environment	Smart environments enabled by devices, network infrastructure, and operating systems	Accord[Humble et al., 2003][Crabtree et al., 2003], Ambient Agoras[Streitz et al., 2003], Paper++[Decurtins et al., 2003], AURA[Garlan et al., 2002], CoolTown[Barton and Kindberg, 2001], EasyLiving[Brumitt et al., 1998], TRON[Takahashi and Namiki, 2003], WorkSPACE[Grønbæk et al., 2003]
U-Media	I/O medias for user's context aware	SOB[Rocchesso et al., 2003]
U-People	Ubiquity-based services for minorities	InterLiving[Westerlund et al., 2003], ASTRID[Woolham and Frisby, 2002]

3. ubiDSS

3.1 The notion of ubiquitous DSS

The ubiDSS research is harmonious to the current trend for the next-generation DSS: e.g. agent-based DSS, active DSS, and web DSS. The ubiDSS aims to support mobile decision makers by allowing them global access to the smart space and/or zone. To do so, ubiquity in ubiDSS can be realized on top of the capabilities as shown in Figure 1:

(1) Embeddedness: small intelligent devices embedded in the physical world and connected to the fixed and/or wireless network.

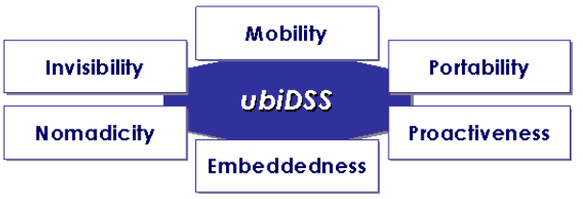
(2) Mobility: the client devices must be operated under the mobile and flexible network infrastructure.

(3) Nomadicity: the system need to provide a rich set of computing and communication capabilities and services to nomads as they move from place to place in a way that is transparent, integrated, convenient and adaptive.

(4) Proactive: the system need to be self-triggered to capture *a priori* what its userwant to act a sort of behavior to increase the quality of service.

(5) Invisibility: the system should not be obtrusive to the user by allowing them to put any data as few as possible. Mark Weiser had a vision for invisibility and disappearing technologies.

(6) Portability: seeing that legacy DSS supports on site decision-making, the ubiDSS provides services with hands-free or at least one-handed light devices.

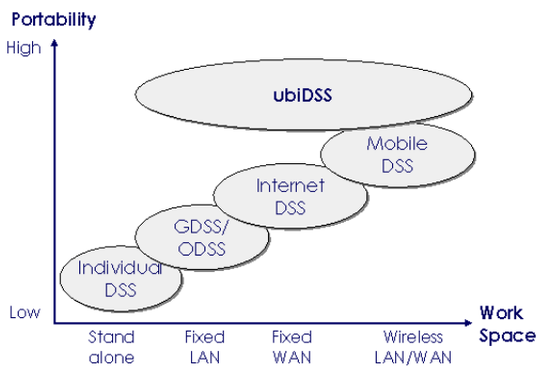


<Figure 1> Capabilities enabled by the ubiquity in

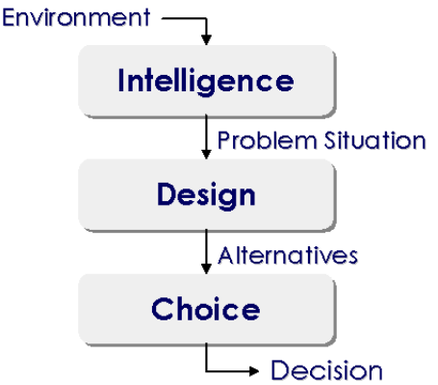
ubiDSS

The ubiDSS is characterized by their ability to identify decision makers even though they are moving, and to allow them to get solutions through any portable devices on any workplaces. As the capabilities of mobility and portability are included into DSSs, the notion of providing management critical information or decision support anytime, anywhere can be realized [Daume and Robertson, 2000]. The ubiDSS is characterized by their ability to identify decision makers even though they are moving, and to allow them to get solutions through any portable devices on any workplaces. Figure 2 shows the locus of ubiDSS comparing with the other legacy DSSs.

Before we discuss the ubiquitous decision support activities, we should clarify the concept of the context which underpins every process for making decision. The context mentioned in ubiquitous computing environment is conceptualized as any information that can be used to characterize the situation of an entity [Prekop and Burnett, 2003]. The information indicates any place and action, or even any event caused by them. Due to the fact that the information possesses users' external and internal intention, by identifying and analyzing the context, we can forecast the following events that will be confronted by users, namely decision makers.



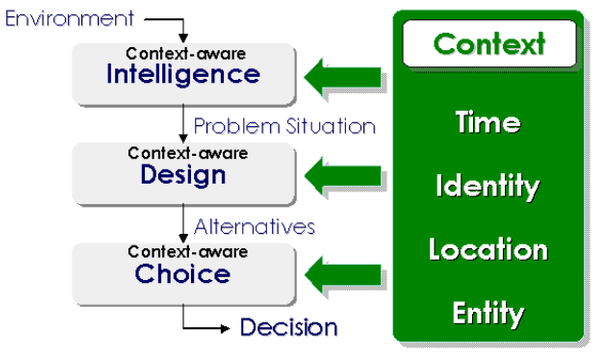
< Figure 2 > Locus of ubiDSS



<Figure 3> Decision Making Process [Simon, 1960]

Context-aware decision making process has the similar concept as shown in Figure 4, which is originated from typical decision making process that Simon has declared in 1960 as Figure 3. Context-aware decision making process is somewhat different from the ordinary one in a sense that the ordinary process mostly resides in the human brain and static information repository because it can be identified by observing and inferring users' cognitive process. On the other hand, since decisions are usually made based on decision makers' intelligence on environments, most of contexts surrounded for making decision are related with the decision maker's problem situation. Similar motivation has led to emerge the concept of, so called, sentient computing, which uses sensors and resource status data to maintain a model of the world which is shared between users and applications [Addlesee et al., 2001][Ipiqa and Lo, 2001].

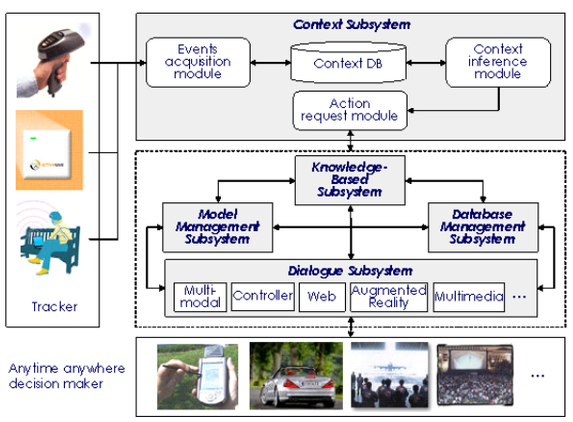
The ubiquitous decision support systems consequently supportthe basic phases of decision making by automatically recognizing decision makers'context, which belongs to the phase of intelligence, and by providing alternatives for making decision through inferring the past data, which belongs to the phase of design. A core capability of ubiquitous computing is context-awareness: sensing time, identity, location, and entity automatically and calmly so that the decision maker may not be obtrusively enforced by the decision support systems.



< Figure 4 > Context-aware decision making process

3.2 ubiDSS framework

Current framework of computer-based information systems, despite of its diversity, can be simplified as a combination of several components: data, model, knowledge, and dialogue with the help of network as shown in Figure 6 When considering ubiDSS, however, one of the most obvious differences is that the ubiDSS acquires context data, as well as data from conventional database. Hence, in ubiDSS, one of the big differences is that context subsystem is added to the conventional DSS components: knowledge-based subsystem, model management subsystem, database management subsystem, and dialogue subsystem. The overall framework is shown as Figure 5.



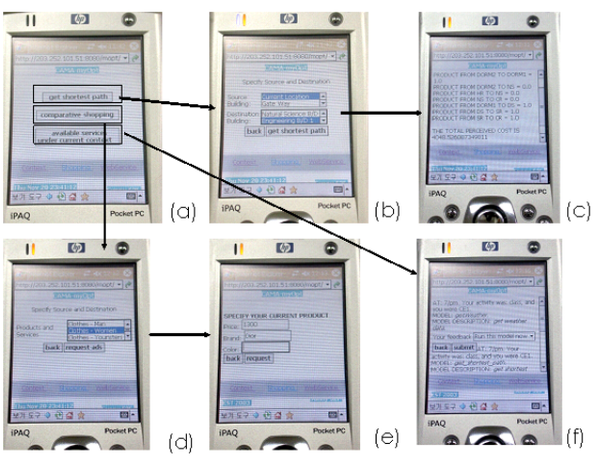
< Figure 5 > Overall framework of UbiDSS

To show the feasibility of ubiDSS, a prototype system, CAMA-myOpt (Context-Aware Multi Agent System - My Optimization) has been implemented. User ontology, product ontology, and service ontology is are implemented with DAML+OIL. The ontology is accessed and interpreted with Jena API. Agents are implemented with JATLite on top of JDK version 1.4.1 version. CAMA-my-Opt implements the negotiator's communication with both seller agents and the coordinator are implemented. Information repositories such as a model base and database are implemented with MS Microsoft Access 2000. Some example screens shots of ubiDSS are shown in Figure 6.

4. Concluding remarks

One of the kernel sof a ubiDSS is the ability to provide provision of context-aware personalized decision-making in an unobtrusive way. It reveals the feasibility of a ubiquitous decision support system implementation that minimizes the user's obligation by using multi-agents and web services technologies that both automatically acknowledge the user's context, and autonomously make decisions on the user's behalf of the user, respectively. In this paper, we have shown how ubiquitous computing technology can be used in personalized and proactive decision support with the help of agent technologiesy and web services.

Even though there arelots of things to do for making a good decision with any time, anywhere, and any devices by using ubiDSS, such as privacy issues and inferring good context from the sensors, fully making use of context subsystem would increase the usability and hence decision quality of DSS.



< Figure 6 > Screenshot of CAMA-myOpt Service

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