A Strategic Grid for Implementing Ubiquitous Computing

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ABSTRACT—This letter offers a general framework representing the most effective strategies for implementing ubiquitous computing, given different levels of organizational information system capacity and business needs. The strategic grid offered here identifies promising movements which may potentially have a significant effect on the future development of ubiquitous computing.

Keywords—Ubiquitous computing, information strategy, strategic grid, strategic matrix.

I. Introduction

Information systems (IS) and information and communication technology (ICT) are helping companies not only to excel but also frequently to survive. In general, technology is a competitive tool which can be used to extend organization capability and to enhance and strengthen entry barriers against competitors. Both IS and ICT have become major facilitators of business activities and have brought about fundamental changes in the structure, operations, and management of business organizations. Internet-based business applications allow businesses to interface easily with customers, suppliers, and other stakeholders and also to carry out more internal business functions focusing on improving operational efficiencies. The evolution in speed and efficiency brought about through IS and ICT has revolutionized the way in which organizations do business. The next step in this evolution involves the move toward ubiquitous computing [1]-[4], in which computers will be embedded in our natural movements and interactions with our environment – both physical and societal. In this letter, a frame work is offered which may be useful in planning the most effective strategies for implementing ubiquitous computing, given different levels of organizational IS/ICT capacity and business needs.

Manuscript received Oct. 04, 2006; revised Feb. 16, 2007.

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II. Theoretical Foundations

Some matrices have been studied to help management decision making with ubiquitous computing. Nakamura believes the first major trend will be a shift from ownership-focused ubiquity to application-focused ubiquity [5]. Lyytinen and Yoo argued that the movement towards ubiquitous computing will integrate the advances from both mobile and pervasive computing [6]. In both [5] and [6], the authors overlook some difficulties in designing information strategies for the future. First, ease in computing is not considered. Prior research suggests that science drives innovation, and thus drives technology and application. The movement towards ubiquitous computing requires computing to be both ubiquitous and easy. Second, there is no strategy for managers as to how to successfully use IS/ICT in a ubiquitous computing environment, even though ubiquitous computing will become a dynamic force changing all kinds of business operations. Organizations should seek and embrace opportunities, employing effective strategies and scarce resources, along with technological and managerial expertise.

III. Strategic Grid

The applications need to be planned and managed from the current state to the goal. The simple concept of a strategic grid enables consensus to be achieved both as a strategy is developed and, later, as the business and its requirements evolve [7].

1. Two Dimensions of Ubiquitous Computing

A. Vertical Dimension (*from Fixture to Ubiquity*)

IT involves two extremes of IS/ICT adoption: fixture and ubiquity. The movement towards ubiquity will integrate advances in both portability and connectivity. Portability indicates the extent to which an application is designed to be

easily carried or moved. Connectivity is the ability of a computing device to connect to other computers or to networks. The main challenges in ubiquity originate from integrating large-scale connectivity with portability.

B. Horizontal Dimension (*from Difficulty to Ease of Use*)

In the horizontal dimension, IT involves two extremes of IS/ICT adoption: difficulty of use and ease of use. The challenge is to create a new kind of relationship of people to computers. Ease of use indicates the extent to which a user believes that using IS/ICT is free of effort. The most profound technologies are those in which the information and communication systems to some extent disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it. The main challenges in ease of use originate from the interface with pervasive computing.

2. Four Aspects of the Current State of Organization

The grid's two dimensions contain four aspects of the current state of an organization and the goal state. The four areas require quite different strategies to achieve successful planning, development, and implementation of the applications because they fulfill different functions at different levels in an organization.

A. Traditional Applications

Traditional applications are difficult to use and are available at typical times in typical locations. The degree of ubiquitous application is in the initial stages.

B. Nomadic Applications

Nomadic applications are those with which users can access the same data regardless of their location. Many people think that "ubiquitous" is just another word for "mobile" in the sense that the network can be accessed anytime, anywhere. However, the mere extension of mobility alone does not result in ubiquitous application. Nomadic applications do not require various devices. Users to carry all information devices are available to users. These applications, however, are difficult to use because of the incompatibility of various devices and interfaces.

C. Intelligent Applications

Intelligent applications have the ability to think, understand, and learn everything about users. Progress in IT, even as it has provided businesses with powerful tools for process innovation, has failed to lead to a concrete improvement in productivity. This failure is chiefly due to the widespread practice in system upgrade efforts by businesses of narrowly focusing on process, rather than on input and output between applications and users. Lyytinen and Yoo emphasize the idea of pervasive computing to obtain information from the environment in which the computer is embedded and to utilize it to dynamically build computing models [6]. Intelligent interaction between users and computers is more crucial at this time. While interaction of applications within a virtual space in the form of input and output between units was brought to a state-of-the-art level with practically no friction or delay, this is not the case within a physical space. In other words, substantial delay occurs in the interaction between humans and computers, which cannot be remedied by increasing the processing capacity of the latter alone. These applications, however, are difficult to use because of the non-portability of the typical devices used at typical locations.

D. Ubiquitous Applications

In organization-wide business operations, IS/ICT has been gaining a higher profile, as managers carry out more and more business activities/processes through IS/ICT, for the greatest potential return (profit) from ubiquitous applications on ubiquitous computing systems.

Many organizations depend on IS/ICT to carry out their core business operations and it has become critical for many

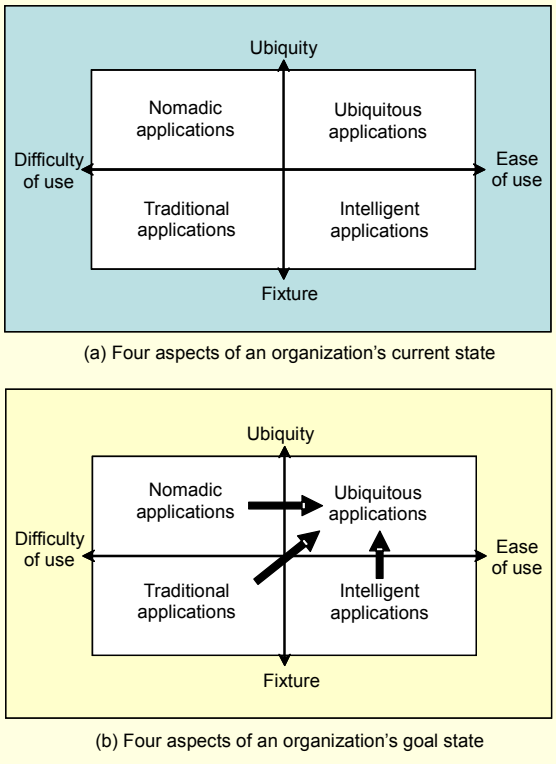

Fig. 1. Strategic grid.

organizations to be able to carry out their business operations and decision making without any inconvenience, anytime, anywhere (see Fig. 1(b)).

IV. Implementation Issues in Moving toward Ubiquitous Applications

1. Fixture to Ubiquity

For users, the movement from traditional and intelligent applications to ubiquitous applications means better connected applications. Portability of applications is fundamentally about increasing our capability to physically move services with us; however, the mere extension of portability alone does not result in ubiquitous applications. It is necessary to reduce the size of the computing devices and/or provide access to computing capacity over ubiquitous networks through lightweight devices. Combined with increasing connectivity of applications, this can enable users to carry services anywhere, making it possible for ubiquitous applications to support the business of a wide array of organizations.

The more familiar users become with systems and their applications, the greater the contribution of fast system responses and easy connectivity will be in enhancing the systems' value. Therefore a system designer needs to consider backup solutions to guarantee uninterrupted connectivity to the server, fine-tuning solutions for fast system responses, offering scale-out and scale-up solutions to guarantee scalability, availability, and so on. Moreover, an auto-regulated network possesses the ability to automatically detect and allocate resources to more efficiently meet the need of users, and to process and execute application demands. Auto-regulated functions include self-reorganization when changes occur to task sets, automatic detection of errors, protection and recovery of the network, restoration of services, self-healing, optimization, and control.

2. Difficulty of Use to Ease of Use

All unit systems consist of three essential elements: input (I), process (P), and output (O). The progress in information technology, following a pattern characterized by Moore's law, has been overly centered on process, only one of three elements comprising the I-P-O structure of a system. From traditional and nomadic applications to ubiquitous applications, progress must be focused on the other two essential elements: I-O.

The evolution of integration and linking technologies is likely to take place through the development of unitary components for applications and services designed in anticipation of the future ubiquitous computing environment. While considerable benefit can be expected from functional unitization and reusability, numerous issues remain to be resolved before their actual application. Individual system development organizations must also prepare themselves for the advent of new technologies and a new system culture, which will inevitably develop with the advent of unitization and reusability. To maximize the potential value of a system to the fullest extent, it is of paramount importance to ensure efficient linkage between its individual units. In order to meet these requirements, a full awareness of system modularization needs to be incorporated in the development of system construction. Under the present circumstances, however, we face such problems as differences in the functional range offered by each component and non-standardized component-to-component interfaces.

V. Conclusion

This letter offers a framework representing the most effective strategies for implementing ubiquitous computing, given different levels of organizational IS/ICT capacity and business needs. Rather than providing a detailed and specific research, the author has quickly identified promising movements with potentially significant effects on ubiquitous computing. The framework presented in this letter would perhaps provide some ideas and directions for further study. This grid will be refined and further developed. Future research will provide examples of how the proposed framework could lead to better management decisions. This letter serves as a good starting point to clarify key relationships and issues.

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