Chapter 11
An Agent-Based Architecture to Ubiquitous Health

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ABSTRACT

Currently, evolution of health services is strongly influenced by the development of information and communication technologies. Distribution of health services brings new challenges to computer systems, with regard to processing capability as well as to communications, storage and security. The proposal explained in this chapter is an architecture design to be easily adapted to advances in healthcare decentralization. It is intended to provide the capability to implement a global distribution of healthcare, even reaching the patient's home, workplace or holiday hotel. This is a distributed architecture which is flexible to implement new functionalities and accessible from anywhere. The architecture is based on the paradigm of agents and defines the different types of agents that may form the system and their interactions.

INTRODUCTION

Information and communication technologies are essential pieces to the development of an enormous variety of knowledge areas such as those related to economics, engineering, advertising, education, etc. Furthermore, the fact that public organizations provide many services via the Internet has allowed computers to be increasingly present in homes.

Health is one of the areas with a high social impact to which computing can be applied. Despite the benefits that information technologies can bring to healthcare, the use of them is not direct and involves more difficulties than in other areas (Goldschmidt, 2005; Tan, 2005). First of all, it should be borne in mind that private information is being handled and must be protected to safeguard patients' privacy (Gritzalis, 2004). Along the lines of security, any transmission of personal health information must be protected to prevent accidental or deliberate interferences that may alter the data (Sulaiman, Sharma, Ma, & Tran, 2007). Moreover, a computer system to be used in healthcare environments should be flexible

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enough to be adapted to new medical protocols or to any advance in the field of medicine.

In order to analyze to what extent information technologies can contribute directly to improve clinical activities, we need to understand the main objective of healthcare organizations. Thus, we are concentrating on their activity, which is aimed at maintaining population health. Health is defined in WHO Constitution as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 2006). Therefore, healthcare professionals' work extends beyond diagnosing and treating diseases. The computer systems to be used in healthcare must be tools that help professionals to ensure that patients reach a state of well-being as stated in the aforesaid WHO's definition.

According to the above definition and focusing on a health management system that is not interfered by economic or political factors, the activities of healthcare organizations can be divided into four main areas: prevention or health promotion, early detection and monitoring, treatment or cure, and maintenance. The improvement of healthcare and, therefore, the effectiveness in the performance of these activities, is limited by population growth, existing resources, both material and human, and scientific advances in medicine.

Population growth, due to both migration processes and increased birth rates and life expectancy, involves increasing healthcare needs. If these needs cannot be met, long-term care activities are usually sacrificed (e.g. prevention activities) in favor of a more direct care focused on diagnosis and treatment. In the same way, lack of material and human resources is tried to be solved: activities that maintain health status are restricted. For their part, advances in medicine are the most directly related to the improvements of healthcare that can affect citizens. Advances in medicine, especially in recent centuries, have greatly increased the body of knowledge, making the specialization of healthcare professionals necessary (Porter, 2006). This working sector does not only include doctors and nurses but also those professionals who collaborate to reach the state of well-being defined by the WHO: psychologists, social workers, physiotherapists, etc.

Decentralization of health services is a strategy that can be followed in order to maximize existing health resources and to integrate the specialization arising from the increase of knowledge in health science into the health system. The most advanced health systems have gone from offering a variety of services in a hospital to distribute them amongst different entities and levels. Thus, there are *hospitals* that have professionals and the most advanced infrastructures to see the most complicated cases. In the next level, there are *specialty centers* that have specialized professionals who could see less serious cases using more limited resources. In the last level, there are *health centers* that are closer to patients and carry out healthcare with the aim of reaching the aforesaid state of well-being, more than treating serious health problems (which would be referred to specialty centers or hospitals) (Lisac, Blum, & Schlette, 2008).

However, it is still possible to define a lower level in health services that would bring healthcare to patients' home. Although there are already some activities that patients can carry out and, then, free health centers of these tasks (e.g. administration of insulin, blood pressure taking, etc.), these activities do not necessarily require professional supervision and are intended more for the patient's own control than for the monitoring of the doctor. The terms *home healthcare* and *hospital at home* refer to a wide range of services available thanks to the possibility of accessing the case history from home. This, for example, makes possible that the monitoring of blood pressure taken by a patient every day is recorded in his health record and reviewed by the doctor.

The decentralization of health services can even be adapted to diagnostic tasks so that a first remote diagnosis can be made through the advice via chat or by videoconference. This initial