Using Object Oriented Technologies to Build Collaborative Applications in Healthcare and Medical Information Systems

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INTRODUCTION

The adoption and diffusion of e-health and the application of IT in healthcare is increasing at a rapid rate. Both European and U.S. governments are making e-health a priority on their agendas. The technical infrastructure required to support initiatives such as community healthcare integrated networks (CHINs) and telemedicine efforts is often dependent upon connecting different types of computer networks, each running on different types of technologies so as to present to the user the image of a single virtual electronic health highway. It is generally agreed that current software development technology cannot deliver this due to limitations of restricted scalability, fragmented management, and inflexibility in providing business support.

One of the potential solutions may be the use of Object Oriented (OO) technology. This article explores the feasibility of combining OO technologies with healthcare based workflow management systems (WFMS). We introduce the concept of workflow technologies and discuss the main advantages and limitations of WFMS. We detail the circumstances in which the use of WFMS could be considered and the technological factors necessary for its successful implementation.

We also present an Object Management Group (OMG) model, analysing it in the context of the support offered for WFMS. The main advantages and disadvantages of the model are discussed. A workflow management coalition (WFMC) model is then contrasted with the OMG management model in order to identify the architectural differences between them. We focus on the relationship between workflow concepts and the position of the two reference models (WFMC and OMG) and on the use of UML in the design of information systems. We conclude by summarizing our findings on the extent to which OO technology can be used to build collaborative applications in healthcare and medical information systems.

BACKGROUND

During his State of the Union Address in January 2004, President George Bush affirmed the intention of the government to emphasize the role of technology in administration and delivery of healthcare in the United States (Bush, 2004). Similar sentiments have been voiced by the European leaders (Global Medical Forum Foundation, 2005; The Oslo Declaration on Health, 2003), and the World health organization ("E-Health in Eastern Mediterranean," 2005; A Health Telematics Policy, 1997). Both European and U.S. authorities define their initiatives primarily in terms of medical information technology centering on computerized patient record (CPR) or, in more acceptable parlance, the electronic health record (EHR). See Brailer and Terasawa (2003).

WHO's platform statement (A Health Telematics Policy, 1997) speaks of "health telematics policy," an all inclusive term that incorporates not only EHR but essentially all healthcare services provided at a distance and based on the use IT.

While implementation of these concepts is preeminently realistic in the context of EU and the U.S.A., the WHO plan appears, for many reasons, a combination of a list of good ideas and delineation of significant obstacles that make the good ideas seem almost futuristic. In response to the inefficiency of the highly fragmented programs to address even the most urgent aspects of healthcare across the globe, a demand for the development of a new rule set (Banjeri, 2004; Bar-

nett, 2004; Olutimayin, 2002; Onen, 2004) governing the future actions began to emerge—the quest for the "doctrine of global health."

To address this void, von Lubitz and Wickramasinghe developed the doctrine of "networkcentric healthcare" (von Lubitz & Wickramasinghe, 2006a, 2006b, 2006c), which calls for the development of interconnected information grids that, together, constitute a powerful and well-structured network that facilitates information sharing among all participants within the operational continuum (Cebrowski & Garstka, 1998; Stein, 1998). Consequent to improved information sharing is the enhancement of its quality and integrity which, in turn, escalates the level of situational awareness that is the foundation for efficient, real-time collaboration among the involved entities, their self-synchronization, and operational sustainability which leads to a dramatic increase in mission effectiveness (Cebrowski & Garstka, 1998).

As described by von Lubitz and Wickramasinghe (2006a, 2006b, 2006c), networkcentric healthcare operations must be conducted within the intersecting territory of three mutually interconnected and functionally related domains (Garstka, 2000):

- The *physical domain* which encompasses the structure of the entire environment healthcare operations intend to influence directly or indirectly, for example, elimination of disease, fiscal operations, political environment, patient and personnel education, and so forth.
- The *information domain* which contains all elements required for generation, storage, manipulation, dissemination/sharing of information, and its transformation and dissemination/sharing as knowledge in all its forms. It is here that all aspects of command and control are communicated and all sensory inputs gathered.
- The *cognitive domain* relates to all human factors that affect operations, such as education, training, experience, political inclinations, personal engagement (motivation), "open-mindedness," or even intuition of individuals involved in the relevant activities. Difficulties in metrics relevant to the cognitive domain notwithstanding, a body of experimental studies begins to emerge that will, ultimately, provide close quantitative relationships to other domains that govern healthcare operations space (Abel-Smith, 1989; Back & Oppenheim, 2001; Bodner et al., 1986; Newby, 2001; Roberts & Clifton, 1992; Wetherell et al., 2002).

The essential and enabling technology element of NCHO is the Worldwide Healthcare Information Grid (WHIG) that allows full and unhindered sharing of information among individual domains, their constituents, and among constituents across the domains (von Lubitz & Wickramasinghe, 2006a, 2006b, 2006c). In order to perform such a function, the WHIG must consist of an interconnected matrix of ICT systems and capabilities (including communication platforms, data collection, storage, manipulation/dissemination, and sharing), associated processes (such as information and knowledge storage and retrieval, management and their dissemination/sharing), people (e.g., healthcare providers/investigators, administrators, economists, politicians, lawyers, ICT personnel), and agencies (governmental and Non-Governmental Organizations or NGSs) at local/national/international level.

However, von Lubitz and Wickramasinghe have not detailed the technological make up of the WHIG which is the backbone of NCHO. We contend that the ultimate use of Object Oriented (OO) technologies as we discuss in this article will be to provide the technological backbone to such initiatives as NCHO or smaller scale initiatives such as community healthcare integrated networks (CHINs) or e-health and telemedicine applications. To fully appreciate the power and benefits that OO technologies bring to effecting superior healthcare delivery, it is necessary first to understand the evolution of IT applications in healthcare and the key challenges to date.

EVOLUTION OF IT APPLICATIONS IN HEALTHCARE

In the 1970s, the focus of IT applications in healthcare was to facilitate better healthcare administration, particularly in routine administrative tasks such as the calculation of patient charges for reimbursement . In the 1980s, the focus shifted to the development of clinical systems to aid in patient diagnosis and treatment (Johns, 1997; Rao, 2001). This trend continued until the late 1990s. A distinguishing feature of this trend was that most of the IT applications in healthcare were developed for very specific uses such as standalone software applications (Rao, 2001). This lack of interop-