

Chapter 22

Response Time Estimation of a Web-Based Electronic Health Record (EHR) System using Queuing Model

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ABSTRACT

Response time measurement of a Web system is critically important to evaluate its performance. This response time is one of the main barriers usually found in the implementation of an effective Electronic Health Records (EHRs) system. The database selected will affect the system performance. This paper presents a comparison of the response times of a EHRs Web system, TeleOftalWeb, using different databases. In order to calculate these times, M/M/1 queuing models is used. Four databases were selected: Oracle 10g, dbXML 2.0, Xindice 1.2, and eXist 1.1.1. The final objective of the comparison is choosing the database system resulting in the lowest response time to TeleOftalWeb.

INTRODUCTION

Analysing the response times of a Web system is a first priority when evaluating its QoS (D'Ambrogio & Iazeolla, 2003; Leung et al., 2002; Subraya & Subrahmanya, 2000). This response time is one of the main barriers usually found in the implementation of an effective EHR system. It is a parameter hard to quantify as it depends on many variables. CPU speed along with the network and database used stand out from the rest (Li et al., 2002). Achieving good response times is key for increasing any organisation's productivity (Doherty, 1982).

Queuing models are commonly used to measure the response time of a Web system. Those models allow performing independent studies of every component of the system: CPU, network, and database. Analysing the model would simplify the calculation of the service time associated to the different system queues separately. Thus, a performance test of the complete Web system can be accomplished. Queuing systems are used to model EHR exchange systems (Huang & Liou, 2007). The notation used to profile those models is Kendall's (a/b/c). First letter describes the input process, second letter, the service time, and the last one, the number of servers in the system (Bonifaci, 2007).

There are many Web applications relating EHRs in different medical specialities like paediatrics (Ginsburg, 2007), emergencies (Amouh et al., 2005), ophthalmology (Chew et al., 1998), cardiology (Taddei et al., 1997), etc. The web-based EHRs system of emergencies is a multi-platform and multi-user Java-developed system (Amouh et al., 2005). In the web-based EHRs system of paediatrics, the authors used open standards (Ginsburg, 2007). Chew et al. (1998) developed the OphthWeb application within an EHRs multi-disciplinary project in Singapore. In Taddei et al. (1997) a Web-based EHRs system was developed and used for the cardiology specialty

in an Italian health institute. The system operates with a double database model.

Ophthalmology is an ideal specialty for testing EHRs because of the use of images and objective measures during diagnosis of eye diseases. We proposed a Web application, TeleOftalWeb, to storage and exchange EHRs, working cooperatively with specialists from the Institute of Applied Ophthalmobiology (Istituto de Oftalmobiologia Aplicada, IOBA) of the University of Valladolid, Spain (De la Torre et al., 2008). The application is focused to store and exchange ophthalmologic EHRs and fundus photographs, in order to provide remote and fast access to specialists. TeleOftalWeb complies with the Health Level 7 / Clinical Document Architecture (HL7/CDA) standards for EHRs storage, and Digital Imaging and Communications in Medicine (DICOM) for medical images. In this article we intend to evaluate the TeleOftalWeb system, finding out the response times for four databases in order to determine which one provides better performance.

In relation to the EHR systems, the importance of the databases against this background has to be stressed, as they are the core of any EHR information system and so, they considerably affect both the response time calculation and the global performance of a system. The browsing times in the databases decisively affect the total response time of a system (Balsamo et al., 2004).

After the in-depth analysis of several commercial and free software databases for TeleOftalWeb, Oracle 10g, dbXML 2.0, Xindice 1.2, and eXist 1.1.1 were selected. All of them allow the EHRs storage in XML format, so that the application meets the clinical information standard HL7/CDA. Oracle 10g database includes a data type called XMLType, to simplify the XML information handling (Oracle, 2009). dbXML 2.0 is a Java developed database available under the GNU licence (dbXML, 2009). eXist database supports different query languages like XPath 2.0 and XQuery 1.0 (Davis et al., 2003; Meier, 2003). Finally, Xindice stores and indexes XML docu-

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