Chapter 15
Integration of Health Records by Using Relaxed ACID Properties between Hospitals, Physicians and Mobile Units like Ambulances and Doctors

Lars Frank
Copenhagen Business School, Denmark

Louise Pape-Haugaard
Aalborg University, Denmark

ABSTRACT
This paper describes an architecture for integrating both stationary health units like hospitals and group physicians with health records of mobile health units like ambulances and doctors at emergency call service. This paper focuses on how it is possible to have high availability in all the integrated health units and at the same time keep the consistency between the health records in the different locations at an acceptable level. In central databases the consistency of data is normally implemented by using the Atomicity, Consistency, Isolation, and Durability (ACID) properties of a Data Base Management System (DBMS) (Gray & Reuter, 1993). This is not possible if mobile databases are involved and the availability of data also has to be optimized. Therefore, this paper describes using relaxed ACID properties across different locations. The objective of designing relaxed ACID properties across different database locations is to make it possible for all the involved locations to operate in disconnected mode and at the same time give the users a view of the data that may be inconsistent across different locations but anyway better than the data in a centralized database with low availability for the users.

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1. INTRODUCTION

Electronic Health Records (EHRs) have high requirements to storage and reusability of information. The stored information has to be available for health care professionals at any given time, and furthermore, the health care professionals also need to be allowed to store new information gathered in a patient-near setting. (Koch, 2006; Digital Health, 2008) To meet the requirements for storage and reusability EHRs are based on large databases. These databases are often created, maintained and used through a DBMS. When using DBMS to manage databases an important aspect involves transactions which are any logical operation on data and per definition database transactions must be atomic, consistent, isolated, and durable in order for the transaction to be reliable and coherent.

The ACID properties of a database are delivered by a DBMS to make database recovery easier and make it possible in a multi user environment to give concurrent transactions a consistent chronological view of the data in the database. The ACID properties are consequently important for users that need a consistent view of the data in a database. However, the implementation of ACID properties may influence performance and thereby slow down the availability of a system in order to guarantee that all users have a consistent view of data even in case of failures. In several situations, the availability and the response time will be unacceptable if the ACID properties of a DBMS are used without reflection. Especially, in the case of distributed and/or mobile databases where a failure in connections of a system should not prevent the system to operate in a meaningful way in so-called disconnected mode.

Information systems that operate in different locations can be integrated by using more or less common data and/or by exchanging information between the systems involved. In both situations, the union of the databases of the different systems may be implemented as a database with so-called relaxed ACID properties where temporary inconsistencies may occur in a controlled manner. However, when implementing relaxed ACID properties it is important that from a user’s point of view it must still seem as if traditional ACID properties were implemented, which therefore will keep EHRs trustworthy for decision making.

In the following part of the introduction, we will give an overview of how relaxed ACID properties may be implemented and used to integrate EHRs from different types of health institutions.

1.1. Relaxed ACID Properties

The Atomicity property of a DBMS guarantees that either all the updates of a transaction are committed/executed or no updates are committed/executed. This property makes it possible to re-execute a transaction that has failed after execution of some of its updates. This property is especially important in replicated databases where inconsistency will occur if only a subset of data is replicated. The Atomicity property of a DBMS is implemented by using a DBMS log file with all the database changes made by the transactions. The global Atomicity property of databases with relaxed ACID properties is implemented by using compensatable, pivot and retrievable subtransactions in that order as explained in Section 2.1. By applying these subtransactions it is allowed to commit/execute only part of the transaction and still consider the transaction to be atomic.

As explained in Section 2.2 the global Consistency property is not defined in databases with relaxed ACID properties because normally such databases are inconsistent and this inconsistency may be managed in the same way as the relaxed Isolation property.

The Isolation property of a DBMS guarantees that the updates of a transaction cannot be seen by other concurrent transactions until the transaction is committed/executed. That is the inconsistencies cause by a transaction that has not executed all its updates cannot be seen by other
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