Managing Demographic Data Inconsistencies in Healthcare Information Systems

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ABSTRACT

Healthcare IT and IS departments have the arduous task of managing the varied information sources into readily accessible, consistent and referential information views. Patient hospital workflows, from admission to discharge, provide a series of data streams for convergences into disparate systems. Protocols such as DICOM and HL7 exist for the purposes of exchanging information within the PACS and RIS information silos in the hospital enterprise. These protocols ensure data confidence for downstream systems, but are not designed to provide referential data cross system in the system-of-systems model. As data crosses the PACS and RIS information domains, data inconsistency is introduced. This paper explores the causes for data disparity and presents a referential data design for disparate systems through the implementation of an XML bus for data exchange and an RDF framework for data semantic.

Keywords: Data Inconsistency, DICOM, E-Health Services, Health System-of-Systems, HL7, PACS, RDF, XML

INTRODUCTION

Healthcare providers typically use technology in a ubiquitous manner. They choose to rely upon the task-specific capabilities of a specific system rather than the integration of all systems in the solution space. A typical example of this would be the advancement of ultrasound technologies for 3-D modeling. Whilst the capabilities of the imaging solutions are highly beneficial to the individual’s unique needs for healthcare, the integration of this system into a greater solution or system-of-systems is often overlooked (Maier, 2005; Maier, 1998). As such, the demographic data accompanying the information may be in a format inconsistent with the requirements for the electronic medical record.

Workflow Management Systems attempt to simplify and control the primary data entry methods to the data environment (Choennia, 2003; Graeber, 1997). However, the design of these systems focuses on an interpretation layer to gather data from varying input sources, including voice and text. There is no guarantee that this information will propagate throughout the system-of-systems, as required. Common
information protocols such as DICOM (Digital Imaging and Communications in Medicine) and HL7 (Health Level Seven) provide a framework by which medical data is communicated. However, these standard protocols are subject to interpretation that allows for a high degree of variance in the presentation of data. This creates problems of data redundancy, and confuses the authoritative provisioning of data with referential copies.

In this paper we present a framework for data exchange and consolidation in the distributed e-health system-of-systems using an XML bus and RDF (Resource Definition Framework). In the next section of this paper, we will discuss the system-of-systems architecture as it is evolving in the health enterprise. We will discuss the Health Level Seven communication protocol and the protocol DICOM. The application of these protocols into solutions for healthcare information repositories is presented with a discussion of both PACS (Picture Archive Communication Systems) and RIS (Radiology Information Systems). The problem of Data Disparity that causes inconsistencies in the intersystem communications will be discussed and the elaborated solution presented. The solution consists of the XML Bus and the RDF extension for DICOM queries. The successes and shortcomings of this design are discussed in the conclusion.

SYSTEM-OF-SYSTEMS ARCHITECTURE FOR E-HEALTH

The electronic healthcare record (EHR) is a merged presentation of the information obtained through various systems in the healthcare enterprise (Hasselbring et al., 2000). Imaging and demographic data contribute to the contents. Additionally, the physician comments, markup and reports also contribute to the record. These individual pieces of the EHR are drawn from many disparate systems throughout the enterprise. The Record Information System (RIS) or alternatively a Health Information System (HIS) will be the primary demographic repository for patient information. As such, this text and contextual information will be used as the primary data source for downstream comparison. The Picture Archive and Communication System (PACS-ADMIN, 2007) will be used as a repository for imaging data (Miltchenko et al., 2003). Figure 1 presents the main components of the electronic health record that need to be integrated and synchronized.

This architecture of system-of-systems describes a large-scale integration of many independent, self-contained systems in order to satisfy the global e-health needs. As the global economy and global business practices increase, individuals tend to be more transient. Their medical histories are an important precursor to successful health care provisioning. Contingent upon this medical history record is the successful integration of data from varied sources (hospitals, clinics, labs, etc.) including the mobile patient’s information. This information must be portable, presentable, and independent of the initial data program from which it was obtained. By far the greatest concern relates to data inconsistency and subsequent inaccuracy in an environment of disparate systems.

Standard protocols such as DICOM (NEMA, 2008), PACS (Cao, 2000) and HL7 (HL7.org, n.d.) are proposed as a framework by which medical data can be communicated within the system-of-systems. However, many inconsistency problems still exist since the focus of these protocols is on data transfer and not data integration and synchronization. In the next sections we will review these protocols and present different problems.

HEALTH LEVEL SEVEN

The HL7 protocol provides an information standard for communicating patients and sites level information into and out of a health information system within the system-of-systems model (HL7.org, n.d.; HL7 Canada, 2002; Neotool, 2007). HL7 allows for a loosely framed communication standard between medical IT
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