

Chapter 14

An Architectural Solution for Health Information Exchange

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ABSTRACT

Health information technology (HIT) systems including electronic health records (EHRs) have a market saturation nearing 92% at individual institutions but are still unsuited for cross-institutional collaboration of stakeholders (e.g., medical providers such as physicians, hospitals, clinics, labs, etc.) in support of health information exchange (HIE) of different HIT systems in geographically separate locations. In the computer science field, software architectures such as service-oriented architecture, grid computing, publish/subscribe paradigm, and data warehousing are well-established approaches for interoperation. However, the application of these software architectures to support HIE has not been significantly explored. To address this issue, this paper proposes an architectural solution for HIE that leverages established software architectural styles in conjunction with the emergent HL7 standard Fast Healthcare Interoperability Resources (FHIR). FHIR models healthcare data with XML or JSON schemas using a set of 93 resources to track a patient's clinical findings, problems, allergies, adverse events, history, suggested physician orders, care planning, etc. For each resource, a FHIR CRUD RESTful Application Program Interface (API) is defined to share data in a common format for each of the HITs that can then be easily accessible by mobile applications. This paper details an architectural solution for HIE using software architectural styles in conjunction with FHIR to allow HIT systems of stakeholders to be integrated to facilitate collaboration among medical providers. To demonstrate the feasibility and utility of HHIEA, a realistic regional healthcare scenario is introduced that illustrates the interactions of stakeholders across an integrated collection of HIT systems.

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INTRODUCTION

The healthcare domain, frequently criticized for its antiquated handling of data using paper-based patient registries in physician practices, has been infused with a multitude of software solutions for Health Information Exchange (HIE) that focus on the integration of patient data from multiple sources to improve quality of care, lower healthcare costs, and support research. Some important driving factors are the Meaningful Use Electronic Health Record (EHR) Incentive Program of Medicare and Medicaid (CMS, 2013) program to promote EHR usage or the Strategic Health IT Advanced Research Projects (SHARP, 2013) program. For example, SHARP has already spawned highly valuable platforms such as Informatics for Integrating Biology and the Bedside (i2b2, 2004) and the Substitutable Medical Apps & Reusable Technology platform (SMART, 2015). At the same time, patient involvement has been increased by initiatives such as Blue Button (Blue Button, 2013) which allows patients simple access to their data or the data of a cared for elderly parent or child collected from participating medical providers (e.g., physicians, nurses, clinics, hospitals, image labs, pharmacies, therapists, etc.). In addition, the fitness market has exploded with a variety of fitness devices (wearable technologies) that link to mobile applications with new initiatives by Apple and Google. Apple has proposed a new HealthKit app (Apple Health App, 2015) for a dashboard to manage health and fitness data, while Google has the Google Fit fitness tracker (Google Fit, 2015). Both companies are moving strongly into the smartwatch market to track motion, heart rate, blood pressure, activity, etc. In addition, Apple also announced ResearchKit (ResearchKit, 2015), an open source framework that allows researchers/developers to create apps in support of medical research; such a transformation will strongly rely on HIE to gather relevant data.

Despite the emphasis on HIE, there have been numerous problems that have been encountered during the same time span, particularly in regards to regional or statewide networks of connected healthcare stakeholders that practice HIE. Some very promising exchanges have failed (e.g., CalRHIO (Robinson, 2010) and CareSpark (Enrado, 2011)) and the progress of regional health information organizations has been described as “discouraging” and “insufficient” (President’s Council of Advisors on Science and Technology, 2010). Even though the adoption of health information technology systems (HITs) by medical providers is starting to approach a wider acceptance, the corresponding and required integration of healthcare data and systems via HIE remains a challenging problem, technologically as well as politically.

On the side of technology, factors that limit adoption of HITs and HIE have been identified (Gomes, Ziviani, Correa, Teixeira, & Moreira, 2012): a high development cost associated with HIE; a lack of agreed upon open-standardization particularly in regards to the sharing and exchange of data; a focus on brute force technology solutions rather than a healthcare process orientation that considers the needs of patients and providers and high data availability across HITs; and, a difficulty in maintaining HIE across multiple HITs that have the potential to evolve with new capabilities. On the political side, there is concern by major medical providers (e.g., hospitals and other healthcare providers in a particular region) that sharing data may lead to losing patients to competitors.

The Meaningful Use Stage 3 guidelines (HIMSS, 2015) were updated in 2015 and require all HIT systems to have cloud services to access, modify, and exchange health-related data, bringing particular focus to cloud interoperability (Baihan & Demurjian, 2017). HIT systems include electronic health records (EHR) and personal health records (PHR). In support of the interoperability and exchange of healthcare data, the international Health Level 7 (HL7) (HL7, 2016) organization has taken a leadership role for standards to allow the integration, sharing, and exchange of electronic healthcare data. Relevant standards include: HL7 Version 2 (HL7 V2, 20016), HL7 Version 3 (HL7 V3, 20016), the

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