Complete interoperability in healthcare: technical, semantic and process interoperability through ontology mapping and distributed enterprise integration techniques

Amanda Joanne Ducrou

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COMPLETE INTEROPERABILITY IN HEALTHCARE

Technical, Semantic and Process Interoperability through Ontology Mapping and Distributed Enterprise Integration Techniques

A thesis submitted in fulfilment of the requirements for the award of the degree

DOCTOR OF PHILOSOPHY

from

UNIVERSITY OF WOLLONGONG

by

AMANDA JOANNE DUCROU
BE (software), MDigMMedia (distinction)

FACULTY OF INFORMATICS
2009
Certification

I, Amanda J. Ducrou, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Informatics, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

Amanda J. Ducrou
25th May, 2009
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List of Abbreviations

HIF-J ............ Health Interoperability Framework – Jini
ADL ............... Archetype Description Language
ADT ............... Admission, Discharge, Transfer
AHML ............. Australian Healthcare Messaging Laboratory
AMR ............... Association of Medical Receptionists
ANSI .............. American National Standards Institute
ARC ............... Australian Research Council
CAP ............... College of American Pathologists
CDA ............... Clinical Document Architecture
CEN ............... European Committee for Standardisation
CIS ............... Clinical Information System
CMT ............... Convergent Medical Terminology
CTv3 .............. Clinical Terms version 3
DICOM .......... Digital Imaging and COmmunication in Medicine
DMIM ............. Domain Message Information Model
DSS ............... Decision Support System
EDI ............... Electronic Data Interchange
EHR ............... Electronic Health Record
ePOC ............. electronic Point-Of-Care
ESB ............... Enterprise Service Bus
FLWOR .......... For, Let, Where, Order by, Return
GEHR ............. Good European Health Record
GP ............... General Practitioner
HL7 ............... Health Level Seven
HMD ............... Hierarchical Message Description
HSB ............... Health Service Bus
ICD ............... International Classification of Diseases
IEEE .............. Institute of Electrical and Electronics Engineers
IHTSDO ........... International Healthcare Terminology Standards Development Organisation
ISO ............... International Organisation for Standardisation
ITS ............... Implementable Technology Specification
JCA ............... J2EE Connector Architecture
Jini .............. Jini Is Not Initials
JMS ............... Java Message Service
JMX ............... Java Management eXtensions
JVM ............... Java Virtual Machine
LOINC ............ Logical Observation Identifier Names and Codes
MeSH .............. Medical Subject Headings
MSMQ ........... Microsoft Message Queue
NHS .............. National Health Service (UK)
NLM .............. National Library of Medicine (US)
OWL .............. Web Ontology Language
PACS ............. Picture Archiving and Communication Systems
PAS .............. Patient Administration System
PDA .............. Personal Digital Assistant
RIM .............. Reference Information Model
RMIM ............ Refined Message Information Model
SCTID ............ SNOMED CT IDentifier
SDO ............... Standards Development Organisation
SESIAHS ........ South East Sydney and Illawarra Area Health Service
SNOMED ........ SNOMED – Clinical Terms
SNOMED CT ..... SNOMED – Reference Terminology
SOA ............... Service-Oriented Architecture
SOAP ............. Simple Object Access Protocol
SQL .............. Structured Query Language
TACT ............ The Ambulatory Care Team
UML .............. Unified Modelling Language
UMLS ............. Unified Medical Language System
WHO .............. World Health Organisation
XML .............. eXtensible Markup Language
XPath ........... XML Path Language
XQuery ........... XML Query Language
XSLT ............ eXtensible Stylesheet Language Transformations
Abstract

Interoperability in healthcare is a requirement for effective communication between entities, to ensure timely access to up-to-date patient information and medical knowledge, and thus consistent patient care. This thesis focuses on the development of an interoperability solution for health by employing design science research methods to arrive at a final solution.

First, background topics including Health Informatics standards and formats are covered, which leads to three major Health Informatics standards being used throughout the remainder of this work – HL7 for messaging, openEHR for patient records, and SNOMED CT as a standard terminology to facilitate clarity of information, and to discourage ambiguity between communicating entities.

Ontology mapping methods between these standards designed to promote interoperability by using the standards in conjunction with each other are then presented, leading to a solution for semantic interoperability.

A technical interoperability solution is required for sending these semantically interoperable messages, which leads to the development of a framework which uses a tuple-space paradigm to share messages. This framework is shown to have some scalability issues, which leads to the final solution – a scalable interoperability framework based on the Enterprise Service Bus methodology of enterprise integration which provides a real-world answer to communication in healthcare.