The Logical Model Designer (LMD) – Binding Information Models to Terminology

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(10:45 – 11:30)
Agenda

• Background
• Logical Information Model
• LMD Tooling
• Terminology Binding
• Demonstration
• Platform Software Architecture
• Project Timeline
Healthcare landscape of the future

Strategic vision of patients moving seamlessly across the healthcare system, receiving coordinated patient-centric care at the most appropriate settings.

Enabled by the National Electronic Health Record (EHR)
Sharing Information Across Singapore

Emergency Department

Acute-Care Hospital

Community Hospital

General Practitioner

Care Co-ordinator

Table:

<table>
<thead>
<tr>
<th>Name</th>
<th>NRIC No.</th>
<th>Date of Birth</th>
<th>Gender</th>
<th>Primary Care Provider</th>
<th>Care Coordinator</th>
</tr>
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<table>
<thead>
<tr>
<th>Allergies</th>
<th>Immunisations</th>
<th>Investigations</th>
<th>Procedures</th>
</tr>
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<table>
<thead>
<tr>
<th>Diagnoses</th>
<th>Current Medications</th>
<th>Recent Events</th>
<th>Recent Referrals</th>
<th>Care Plan</th>
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Applications that are not a part of the EHR solution, but will be integrated with the EHR
Use Case for Standards

- **Messaging** – safe exchange of transactional data
- **Document Exchange** – safe exchange of documents
- **Persistence** – storing data in clinical systems
- **Interoperability** – ability to interpret semantics of data received from other clinical systems and store in native data stores
- **Querying & Analytics** – over multiple heterogeneous sources
- **Decision Support** – ability to define and apply decision support rules over shared data
MOHHoldings Standards Products

- **Diagnosis** - SNOMED CT*
- **Drugs** - Singapore Drug Dictionary (SDD)
- **Allergic Reactions** - SNOMED CT*
- **Allergens** - SNOMED CT* + SDD
- **Laboratory Results** - LOINC (TBD)
- **Data Dictionary** - MOHH Data Dictionary
- **Procedures** - TBD
- **Reason for visit** - SNOMED CT*
- **Symptoms and Problems** - SNOMED CT*
- **Laboratory Reports** - Smart SNOMED CT*
- **Laboratory Orders** - SNOMED CT*
- **Radiology Orders** - SNOMED CT*

SNOMED CT* includes Singapore Extension
1. A common, implementation-independent model of all shared healthcare information in Singapore.

2. A ‘single source of truth’ that articulates our clinician and business information requirements.

3. Implementation artefacts are generated from common semantics.
LIM Development Process

ISO 13606, ISO 21090, and SNOMED CT are adopted by the Logical Reference Model (LRM).

Logical Reference Model (LRM) constrains the Logical Information Model (LIM), which is a set of Archetypes.

Logical Information Model (LIM) constrains Logical Message/Document Model (Templates aka NDDs).

LRM XML Schema is serialised in XML to Logical XML Schema (LXML), which is validated by XSLT.

LXML Message/Document Instantiates HL7 v2.3.1 Message.

Legend:
- NDDS = National Data Definition Specification
- NXDS = National Exchange Data Specification

Evidence-based approach involving analysis of existing healthcare information exchange:

Data Exchange Requirements:
- Clinician-driven approach to gathering requirements for the NEHR and discharge summaries.
Logical Reference Model

The EHR Extract comprises a hierarchy of Folders

Compositions contain...

Sections (which may be nested)

Entries with data as...

Elements

Clusters

Clusters may be nested

& contain Elements
Archetypes and Templates

Archetypes
- Reusable clinical models
- Defined as a set of constraints on the reference model
- For example:
  - Observation, Diagnosis, Alert, Adverse Reaction, Investigation Result
- Can be further constrained – e.g. Heart rate, Microbiology Result

Templates
- Group together a set of archetypes for a specific use case
- Apply additional use-case specific constraints
- Can be used to standardise the elements, constraints and terminology for a given message type, user interface etc
- For example:
  - Discharge summary, Investigation Report, Prescription
Example Model

Archetype Editor

Complex Node

- **UID:** 948f5ea3-ce33-41cb-abda-6c70e2283e39
- **Name:** Example Model
- **Node ID:**

**Defining Information**

- **Reference model attribute:** value: ANY
- **Reference model type:** CD
- **Flavour:** CD.CWE

**Constraints**

- **Min. cardinality:** 1
- **Max. cardinality:** 1

**Other constraints**

**Descriptive Information**

**Values**

- **Constructor binding:**
- **National Value Domain**
  - **Simple:** Investigation Name

**Business Data Element Name**

**Data Type**

**Cardinality**

**Value Domain**
Terminology Challenges

Example: “Suspected Lung Cancer”

We need a consistent semantic representation.
IsoSemantic Models (example instances)

e.g. “Suspected Lung Cancer”
Problem Diagnosis = $\text{ProblemDiagnosisName}$:
246090004 | associated finding | = (404684003 | Clinical Finding |:
363698007 | finding site | = ($\text{BodySite}$:
272741003 | laterality | = $\text{Laterality}$),
246112005 | severity | = $\text{Severity}$),
408729009 | finding context | = $\text{FindingContext}$

GP Problem Diagnosis = 86049000 | Cancer | :
246090004 | associated finding | = (404684003 | Clinical Finding |:
363698007 | finding site | = 39607008 | Lung |),
408729009 | finding context | = 415684004 | Suspected |

Polyclinic Problem Diagnosis = 162572001 | Suspected cancer | :
246090004 | associated finding | = (404684003 | Clinical Finding |:
363698007 | finding site | = 39607008 | Lung |)

RH Problem Diagnosis = 162573006 | Suspected lung cancer |
Benefits of the LIM

- Common model
  - shared healthcare information in Singapore

- Common queries
  - Provides a common vocabulary for querying multiple data sources

- Common meaning
  - Each clinical meaning is represented just once and reused many times

- Consistent terminology
  - National reference terminology bound to a clinical meaning

- Implementation independent
  - Information model independent of exchange format and proprietary information models

- Machine processable model
  - Allows information to be defined once, and used many times (consistently)

- Conformance Testing
  - Enables the automation of Conformance Testing to ensure quality of data
Logical Model Designer (LMD)

- **Implementation Artefact**
  - Logical-XML, HL7 v2, Java

- **Documentation Artefact**
  - Word, Excel, HTML

- **Compiled Template Hierarchy**
  - Logical-Object Model (LOM)

- **Template Definition**
  - Logical-Object Model (LOM)

- **Constrained Clinical Archetypes**
  - Logical-Object Model (LOM)

- **Clinical Archetypes**
  - Logical-Object Model (LOM)

- **Logical Reference Model (LRM)**
  - ISO-13606 + ISO-21090

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Clinician Verification

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Snow Owl

- Terminology
  - Examples
  - Value sets
  - Constraints
  - Meaning
Logical Model Designer (LMD)

- Implementation Artefact
  - Discharge Summary LXML + Java CC Testing

- Documentation Artefact
  - Discharge Summary Hierarchy (Excel, HTML)

- Compiled Template Hierarchy
  - Discharge Summary Hierarchy

- Template Definition
  - Discharge Summary

- Constrained Clinical Archetypes
  - Heart Rate

- Clinical Archetypes
  - Observation

- Logical Reference Model (LRM)
  - Composition, Entry, Cluster, Element

Clinician Verification

Snow Owl

Terminology

- Examples
- Value sets
- Constraints
- Meaning
Types of Terminology Binding

- **Value set binding**
  - *National*: For national queries over heterogeneous data
  - *Local*: For generating conformance/compliance software for messages populated using local value sets (mapped to national)

- **Constraint binding**
  - Assumed, fixed and default values
  - OCL and ESCG constraints

- **Semantic binding**
  - Enables querying data using more general or specific meanings
  - Enables searching models, and identifying semantic overlap

- **Relationship bindings**
  - Defines meaning of relationship between parent to child node
  - Used to construct design pattern bindings (aka constructor bindings)

- **Design pattern bindings (aka ‘constructor bindings’)**
  - Extended compositional grammar expression with path-based slots
  - Used to normalise data that may either be precoordinated or postcoordinated in the structure, into a canonical form
**Terminology Binding Syntax**

- **Uniform Resource Identifier (URI) standard:**
  - Simple and extensible means for identifying a resource (ftp:, mailto:, news:, etc.), in this case terminology artefacts
  - Logical identifier of a resource, **without** specifying the physical location and the access mechanism
  - Both human and machine readable, with the syntax:
    
    `<scheme name>:\<hierarchical part>[?\<query>][\#\<fragment>]`
  
  - Obtaining a representation of the resource is done by Resolvers

- **Scheme for terminology binding:**
  
  `terminology:\<code system id>[:version]?\<query type>= \<query expression>\&\<extension key>=extensionvalue`*

- **SNOMED CT query types:**
  - concept, conceptlist, refset, refsetlist, escg, ocl
Terminology Binding Examples

```
terminology:<code system id>[version]?<query type>=<query expression>[&<extension key>=extensionvalue]*
```

Examples:

**SNOMED CT**
- terminology:2.16.840.1.113883.6.96:20110123?concept=284296006
- terminology:2.16.840.1.113883.6.96:20110123?refset=284296007&scope=A01324
- terminology:2.16.840.1.113883.6.96:20110123?escg=<<284296006

**ATC**
- Terminology:2.16.840.1.113883.6.3:20110123?code=A01

**Singapore Data Dictionary**
- terminology: data_dictionary_id?value_domain_id#code
Binding Terminology to a Coded Datatype

SNOMED CT

Concept Id
2.16.840.1.113883.6.96

SNOMED CT
20110701

Preferred Term

Description Id
Assumed value: PT

RefSet Id

RefSetVersion
Binding Terminology to a Coded Datatype

ICD-10

Code

2.16.840.1.113883.6.3

ICD-10

2008

Description

Assumed value: Desc

Value Domain Id

Value Domain Ver
Binding Terminology to a Coded Datatype

**DD Value Domain**

- **Assumed value**: Desc
- **Value Domain Id**: Value Domain Id
- **Value Domain Ver**: Value Domain Ver
- **Code**
- **DD OID**
- **MOH Data Dictionary**
  - 20120101
- **Description**

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**CD**

- `code : String [0..1]`
- `codeSystem : Uid [0..1]`
- `codeSystemName : String [0..1]`
- `codeSystemVersion : String [0..1]`
- `term : ST [0..1]`
- `termId : String [0..1]`
- `originalText : ST`
- `valueSet : Uid [0..1]`
- `valueSetVersion : String [0..1]`
Demonstration of LMD Tooling

- **Snow Owl**
  - Reference sets and Extension concepts

- **Logical Reference Model (LRM)**
  - Editable view

- **Archetype – Observation ENTRY**
  - Add semantic and value domain bindings
  - Node meaning, relationship meaning, constraint & constructor bindings

- **Constrained archetype – Heart rate ENTRY**
  - Add semantic and value domain bindings
  - Confirm subsumption validation

- **Compile template – Discharge summary (with heart rate)**
  - Fill slot with heart rate archetype, and

- **Model search**
  - Search models using semantic bindings
Built on the seasoned Eclipse tooling platform with wide industry adoption
  - Composed of bundles running within an OSGi (Eclipse) container
  - Bundles can be deployed depending the product definition (possible for both client and server side)
  - Help and branding information are in separate bundles

Utilizes the services provided by the Snow Owl terminology platform

Core domain objects are modeled via standard EMOF as opposed to be hard-coded
Platform Software Architecture

Modularity & extensibility

Snow Owl

Exposed extension point

com.b2international
com.b2international
com.b2international

Exposed service

OSGi container

LMD

Eng.com.mohh.lmd
Eng.com.mohh.lmd
Eng.com.mohh.lmd

org.eclipse

Branding

org.eclipse

Confidential
Platform Standards Stack

Runtime API access
- REST, SOAP

Healthcare semantics
- LIM
- Ontologies: SNOMED CT, ICD-10

Healthcare standard agnostic modeling
- EMOF (EMF)

Runtime platform
- Scalability, modularity
- OSGi (Eclipse), JDBC
Project Timeline

- 2012 April – LMD Project kick-off

- **V0.4: 2012 November 3 – current release**
  - Existing MOHH LIM artefacts import
  - Modelling artefacts browsing, searching and editing capabilities (archetype, constrained archetype, template, template hierarchy)
  - Validation framework
  - Terminology binding
  - Schema and instance generation

- **V0.9: 2013 June 3 - Final release**
  - Instance conformance & compliance
  - Mapping support
  - Logical query language support
  - Publication
  - ADL Support