Using OpenEHR platform and HL7/IHE interoperability

Think!EHR Platform – open health data platform

Better Data Better Care

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www.marand.com

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Company Facts

- **15M EUR** revenue
- **120 employed** professionals
- **80 experienced software developers**
- Products, References and domain knowledge in **healthcare and telecommunications**
- **25 years** in IT
- **ISO 9001 & 27001 certified**
Marand HealthCare Solutions

- National **OnLine** Health Insurance Card
- Cancer **Registry** of Slovenia, Cancer **Screening**
- **Think!Med Clinical™** systems
  - Institute of Oncology
  - UMC Ljubljana – Children’s Hospital Cardio Surgery, Infections Clinic, Nuclear Medicine, Radiology
- **Think!EHR™** Platform
  - Slovenia’s national **eHealth** Infrastructure
  - City of **Moscow** eHealth Project
Partners

Healthcare vendors

System integrators

Technology partners

Content partners
The Quest for the Holy Grail

Structured Data

Part of The Mythical Quest - In search of adventure, romance and enlightenment.
Motivation

- EHR structured data
  - compute health information
    - Clinical Decision Support
    - Patient Safety
    - Registries
    - Population Health
    - Business intelligence for payers
    - Medical research
    - Personalized-medicine
  - historically heated debate (data standards problem)
    - HL7 RIMv3, ISO13606, OpenEHR
    - Data normalization
Simple question...

- What is the percentage of patients with high BMI?
- How many diabetes patients are controlling their sugar?
- How many patients have been diagnosed with Crohn’s disease last year?
Semantic underpinning

- OpenEHR framework

Use-case specific data-set definitions

All possible item definitions for health

Defined connection to terminology

Portable, model-based queries

Defines all data

Templates

Archetypes

Reference Model

Terminology interface

Terminologies

ICPC

ICDx

Snomed CT
Vertical semantic framework from GUI to Storage

Concrete: GUI, messages, documents

1:N

Business-event specific data sets - Templates

1:N

Theme-based models of content - Archetypes

1:N

Data Representation and sharing - Reference Model

Terminology Interface

Querying

Discharge summary UI form

HbA1C, phys. exam, meds list, vital signs etc

Observation, Quantity, coded text etc
Model-based querying

- The openEHR community has defined a query language spec based on archetypes called AQL – Archetype Query Language
- Compositions (records) are based on templated archetypes
- Archetypes are hierarchical in structure, and every node can be addressed by its path (locatable)
- Query based on clinical models, independent of persistence / storage model
AQL in a nutshell

- SQL + path syntax to locate nodes or data values within archetypes

SELECT
  data elements to be returned

FROM
  query data source
  CONTAINS
  Containment (matches context)

WHERE
  set filtering criteria on archetypes or any node within the archetypes

ORDER BY
  result ordering
AQL example

- Population Query for high blood pressure records

```sql
SELECT
  bp/data[at0001]/events[at0006]/data[at0003]/items[at0004]/value/magnitude as Systolic,
  bp/data[at0001]/events[at0006]/data[at0003]/items[at0005]/value/magnitude as Diastolic
FROM EHR e
  CONTAINS COMPOSITION c
  CONTAINS OBSERVATION bp/openEHR-EHR-OBSERVATION.blood_pressure.v1
WHERE
  bp/data[at0001]/events[at0006]/data[at0003]/items[at0004]/value/magnitude>110 and
  bp/data[at0001]/events[at0006]/data[at0003]/items[at0005]/value/magnitude>80 and
```

- Returning a Result Set

<table>
<thead>
<tr>
<th>#</th>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>122</td>
<td>83</td>
</tr>
<tr>
<td>2</td>
<td>117</td>
<td>81</td>
</tr>
<tr>
<td>3</td>
<td>111</td>
<td>83</td>
</tr>
<tr>
<td>4</td>
<td>112</td>
<td>83</td>
</tr>
</tbody>
</table>
AQL on the Battlefield

- Complete EMR
  - Part of University Medical Center Ljubljana
  - 10 specialities, including ICU and surgery
- New, state-of-the-art facility
  - 200+ beds, 14 ICU, 4 OR, 5 Recovery
  - PCs, Touchscreens, iPads
  - New medical devices
- Integrated barcode, medical devices
- All clinical content in archetypes
AQL in EMR – Lines, Tubes, Drains
AQL in EMR – Labs
AQL in EMR – Body Fluids
AQL in EMR – Medication Administration
AQL in EMR – Clinical Decision Support

4.7.2013 08:00 — 09:55 / Majda Oštir
The patient is stable. In the evening vomited. This morning on the diet. In the morning, well received by the food. After breakfast fever. Parents visiting.

3.7.2013 12:00 — 16:02 / Danijela Teskač
In the morning, changes in therapy, introduced thoracic drain right and on behalf of dr. Krivec on subabvalni suctioning. Aspirate the guest yellow secretion from the tube, a lot of old blood from the mouth. Made oral care, refreshing bath. My parents are visiting.

3.7.2013 12:00 / Danijela Teskač
Vital stable. Breath itself PEJ 3l of oxygen, then it reduces the saturation of 100%. Saturation are good, nice breath. From the cannula to aspirate it thicker as well as secretion from the nose. Made bandage arterial line. The food is well tolerated. Repeatedly discharged mud. My mom was visiting and nurturing. On the abdomen, around the anus persist hematoma.

3.7.2013 08:00 / Majda Oštir
Vital and circulatory stable, slight subsiding, and then
Health Data Analytics
Think!EHR Explorer

AQL Query Editor
Think!EHR Explorer

AQL Query Builder (QBE)
Think!EHR Explorer

AdHoc Input Form Generator
### Think!EHR AdHoc Form Generator

#### Eye assessment - with image

**Left side**
- **Pupil shape**
  - Normal, circular
  - Oval
  - Irregular
  - Sectoral
- **Iris colour**
  - Blue
- **Pupil size**
  - [ ] mm
- **Estimated size**
  - Pin-point pupil (≤ 1mm)
  - Constricted pupil (1.5-2.5mm)
  - Normal pupil size (3-5mm)
  - Dilated pupil (≥ 5.5mm)

**Right side**
- **Shape**
  - Normal, circular
  - Oval
  - Irregular
  - Sectoral
- **Iris colour**
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- **Pupil size**
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- **Estimated size**
  - Pin-point pupil (≤ 1mm)
  - Constricted pupil (1.5-2.5mm)
  - Normal pupil size (3-5mm)
  - Dilated pupil (≥ 5.5mm)
- **Direct light reflex**
  - Present
- **Speed of light reflex**
  - Sluggish/slow
  - Normal
  - Brisk
- **Consensual light reflex**
  - Present
- **Accommodation reflex**
  - Present
- **Afferent defect**
  - Absent
  - Present
Nation wide EHR / eHealth platform

• Slovenia’s national eHealth Infrastructure
  - Scale: 2 mio. population
  - IHE / OpenEHR ecosystem

• Moscow City EHR Project
  - Scale: 12 million patients, 1B documents
  - Many applications, vendors, one CDR
  - eHealth platform for the future
  - Short time-to-delivery
City of Moscow eHealth platform

Moscow city - **780 medical facilities**, including:
- 149 hospitals, 76 health centers, 428 policlinic institutions

Volume:
- Patients- **12 million**, Beds in hospitals – **83,000**
- Physicians – 45,000, all users – **130,000**
- Patient visits/year - **161 million**
- Documents/year - **1 Billion, 25TB**

- Pilot **live** at 6 clinics as of Aug 2013!
ThinkEHR Performance/Volumetrics

Test Environment / IBM PureSystem
- EhrSrv HW: 2 x 6 Core CPU 3.4 GHz, 96 GB RAM, SAN StorWize V7000

Single EhrSrv Node performance:

<table>
<thead>
<tr>
<th>#Ehr_ID</th>
<th>#Compositions</th>
<th>Storage (GB)</th>
<th>Read avg (95p)</th>
<th>Write avg (95p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,000,000</td>
<td>100,000,000</td>
<td>242 IDX, 390 Data</td>
<td>12.8 (40)ms</td>
<td>60.2 (145)ms</td>
</tr>
</tbody>
</table>

Test Environment / Oracle ExaData X2-2 + ExaLogic
- 8 node RAC (with partitioning)
- 14 x EhrSrv HW: 2 x 6 Core CPU 2.9 GHz, 96 GB RAM, SAN ZFS 7420

- 20mio EhrId & 1b documents
- Throughput: 7mio docs/hour
- 39k AQL TPS
EhrScape.com

Build amazing healthcare apps and services

open API + open Data = open Health Data Platform

A simple yet powerful API
Healthcare computing as a service
By developers for developers

Health app development shouldn't be harder than other verticals. EhrScape is all about making awesome healthcare apps easy to build and integrate into your environment.
Healthcare computing that just works. EhrScape handles all the hard bits, including detailed clinical models, semantic interoperability, vendor independent data storage, health data query and more.
Our mission is to empower you to build amazing healthcare apps and services. Welcome aboard. We're just getting started and we've got very big plans!
<table>
<thead>
<tr>
<th>Benefits</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration profiles</td>
<td>Querying limited to document metadata</td>
</tr>
<tr>
<td>Strong industry support</td>
<td>Minimal data-set content Profiles / coarse grained data</td>
</tr>
<tr>
<td>Focused on document sharing</td>
<td>Mostly CDA L1/L2</td>
</tr>
<tr>
<td>Aids integration</td>
<td>Mostly non-computable health data</td>
</tr>
</tbody>
</table>
IHE XDS/OpenEHR

- **PIX XREF Manager**
- **Patient Identity Source**
- **Document Registry**
- **Document Consumer**
- **Document Source**
- **OpenEHR CDR**

Flow of processes:
- **Patient Identity Feed** from PIX XREF Manager to Patient Identity Source
- **Query Documents** from Document Registry to Document Consumer
- **Provide and Register Document Set** from Document Source to Document Registry
- **Retrieve Document** from Document Consumer to Document Registry

Additional components:
- **Patient Identity Feed**
- **PIX Query** from Patient Identity Consumer to PIX XREF Manager
- **Register Document Set** from Document Registry to Document Consumer
IHE XDS/OpenEHR

- MPI (PIX/PDQ)
  - EhrId as identifier in the MPI

- OpenEHR CDR with XDS.b Repository I/F
  - TDS/TDD – Greenfield structured data exchange
  - CDA L1/L2 – simple transform
  - CDA L3/RIM – transform
Single level mapping (ad-hoc?)

- There is a direct relationship between the instances and their schemas
  - It is “only” a matter of assigning a source path to a target path (maybe with some data operations).

  - $\text{SOURCE}/\text{temperature} \rightarrow \text{TARGET}/\text{temperature}$

- There are lots of tools for doing this…
1.5 level mapping

- Transform based on “knowing” source/target RM
Two level mapping

- When we use a dual-model it becomes more complicated
  - The archetype defines a sub-schema that must be used during the mapping process.
  - We can generate an ad hoc schema, specific for each archetype, but this solution can potentially create maintenance and interoperability problems.

- Mapping between different reference models

[www.linkehr.com](http://www.linkehr.com)
Data bending

- SMART Platform
- FHIR
- Odata
- Business Objects (EA)

### Views

<table>
<thead>
<tr>
<th>Admin</th>
<th>Category</th>
<th>Name</th>
<th>Description</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fhir</td>
<td>Observation</td>
<td>Observation FHIR resource</td>
<td>jsonAql, js, atom</td>
</tr>
<tr>
<td></td>
<td>fhir</td>
<td>Patient</td>
<td>Patient FHIR resource</td>
<td>demographics_v2, js, atom</td>
</tr>
<tr>
<td>[Del]</td>
<td>smart</td>
<td>demographics</td>
<td>SMART demographics</td>
<td>demographics_v2, ftl</td>
</tr>
<tr>
<td>[Del]</td>
<td>smart</td>
<td>family_history</td>
<td>SMART Family History</td>
<td>jsonFtIAql, ftl</td>
</tr>
<tr>
<td>[Del]</td>
<td>smart</td>
<td>vital_sign_sets</td>
<td>SMART Vital Signs</td>
<td>jsonFtIAql, ftl</td>
</tr>
<tr>
<td>[Del]</td>
<td>view</td>
<td>allergy</td>
<td>Gets allergies for a patient</td>
<td>jsonAql</td>
</tr>
<tr>
<td>[Del]</td>
<td>view</td>
<td>blood_pressure</td>
<td>Gets recorded blood pressures for a patient</td>
<td>jsonFtIAql</td>
</tr>
<tr>
<td>[Del]</td>
<td>view</td>
<td>body_temperature</td>
<td>Gets recorded body temperatures for a patient</td>
<td>jsonFtIAql</td>
</tr>
</tbody>
</table>
Data origami

- Semantic underpinning
- Protocol converter
- Data decorations
- FreeMarker
  - TemplatingEngine