Substitutable Medical Apps
Reusable Technologies

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www.smartplatforms.org
Substitutable Apps need

UI
Standards-based integration (HTML5)

Data
Context (container, user, patient)
Medical (Problems, Allergies, etc.)

API
Resource oriented, everything gets a URL

Authentication
Consistent delegation with Web standards (OAuth)
SMART Vocabulary

Apps
- Got Statins?
- BP Centiles
- Cardiac Risk

API
- SMART-Enabled PCHR
- SMART-Enabled EMR
- SMART-Enabled HIE

Containers
Substitutability = choice

Apps

Got Statins?

BP Centiles

Cardiac Risk

Container

SMART-Enabled
PCHR

SMART-Enabled
HIE

SMART-Enabled
EMR

Got Statins?
Substitutability = re-use
GOAL: Substitutable Apps

SMART Reference EMR

SMART i2b2

Your SMART system here
Technical role models

Facebook

OpenSocial

Google

Web apps run on separate servers with different implementation stacks
SMART Components
SMART Components
SMART Components

Cardio risk
SMART App
Backend

SMART EMR
Allergies
Labs
Meds

Cardio risk

Patient John Smith

SMART Connect
SMART Components
Substitutable Apps need

UI

HTML5
Substitutable Apps need UI

SMART EMR

Patient John Smith

Allergies
Labs
Meds

<iframe src='http://myapp.com'/>
Substitutable Apps need Data context, medical data
Substitutable Apps need

**Data**

information *exchange* (e.g. CCD)

vs.

discrete *normalized* data elements ✓
Substitutable Apps need data

“The best way to manage and store data for advanced data-analytical techniques is to break data down into the smallest individual pieces that make sense to exchange or aggregate.”

—PCAST Report on Health IT
Substitutable Apps need Data

leveraging standard terminology

... simplifies our own models

(SNOMED CT, RxNorm, LOINC... )
Substitutable Apps need *Data*

**Contextual:** patient, physician, ...

**Medical:** blood pressure, cholesterol, ...

Where do HIT standards apply?
Health IT Standards Today ...

Focused on *document* exchange

Not open or free

Not adequately expressive

Not unambiguous

Not easy to learn

**Summation:** Not *developer-friendly*
CCR Example

Licensee may access and download an electronic file of a Document ... for temporary storage on one computer ... or printing one copy. ...

Neither the electronic file nor the single hard copy print may be reproduced in any way.
Not free ...

### HL7 STANDARDS LISTED IN HHS' FINAL RULE

<table>
<thead>
<tr>
<th>Item</th>
<th>Member</th>
<th>NonMember</th>
<th>Add</th>
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</tr>
<tr>
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<td>$0</td>
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### HL7'S VERSION 3 MESSAGING STANDARD

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</table>
Not adequately expressive ...

Blood pressure expression needs:

- position of patient
- site of measurement
- measurement technique
- cuff size

### Table 2-33 Vital Signs Data Mapping Table—Definitions

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Name</th>
<th>Definition</th>
<th>Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01</td>
<td>Vital Sign Result ID</td>
<td>An identifier for this specific vital sign observation</td>
<td></td>
</tr>
<tr>
<td>14.02</td>
<td>Vital Sign Result Date/Time</td>
<td>The biologically relevant date/time for the vital sign observation</td>
<td></td>
</tr>
<tr>
<td>14.03</td>
<td>Vital Sign Result Type</td>
<td>A coded representation of the vital sign observation</td>
<td>C83-[DE-14.03-1] Vital signs <strong>SHOULD</strong> be coded as specified in HITSP/C80 Section 2.2.3.6.4 Vital Sign Result Type.</td>
</tr>
<tr>
<td>14.04</td>
<td>Vital Sign Result Status</td>
<td>Status for this vital sign observation, e.g., complete, preliminary</td>
<td></td>
</tr>
<tr>
<td>14.05</td>
<td>Vital Sign Result Value</td>
<td>The value of the result, including units of measure if applicable</td>
<td></td>
</tr>
<tr>
<td>14.06</td>
<td>Vital Sign Result Interpretation</td>
<td>An abbreviated interpretation of the vital sign observation, e.g., normal, abnormal, high, etc</td>
<td></td>
</tr>
<tr>
<td>14.07</td>
<td>Vital Sign Result Reference Range</td>
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Not easy to learn...

```xml
<observation classCode="OBS" moodCode="EVN">
  <templateId root="2.16.840.1.113883.3.88.11.83.15" />
  <templateId root="2.16.840.1.113883.10.20.1.31" />
  <templateId root="1.3.6.1.4.1.19376.1.5.3.1.4.13" />
  <!-- Result observation template -->
  <id root="107c2dc0-67a5-11db-bd13-0800200c9a66" />
  <code code="30313-1" codeSystem="2.16.840.1.113883.6.1" displayName="HGB" />
  <statusCode code="completed" />
  <effectiveTime value="200003231430" />
  <value xsi:type="PQ" value="13.2" unit="g/dl" />
  <interpretationCode code="N" codeSystem="2.16.840.1.113883.5.83" />
  <referenceRange>
    <text>M 13-18 g/dl; F 12-16 g/dl</text>
  </referenceRange>
</observation>
```
Inspiration from PHR models

Indivo
wiki.indivohealth.org/index.php/Indivo_Document_Model

Microsoft HealthVault Data Types
developer.healthvault.com/types/types.aspx

Google Health CCR Subset
code.google.com/apis/health/ccrg_reference.html
SMART data model

80/20 approach
  e.g., concentrate on common outpatient data

Specify payloads in standard medical nomenclatures
  e.g., SNOMED

Extensible semantic representations in RDF
  Ideal for iterative construction over time
## Common outpatient data

<table>
<thead>
<tr>
<th>Allergy</th>
<th>Immunization</th>
</tr>
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<tbody>
<tr>
<td>Allergy Exclusion</td>
<td>Lab Result</td>
</tr>
<tr>
<td>Demographics</td>
<td>Medication</td>
</tr>
<tr>
<td>Encounter</td>
<td>Problem</td>
</tr>
<tr>
<td>Fulfillment</td>
<td>Vital Signs</td>
</tr>
</tbody>
</table>
Data principles

Translate local codes into medical nomenclature (keeping provenance)

Medications: RxNorm (SCD, SBD, Packs)

Problems: SNOMED CT

Labs: LOINC
SMART data model example

A **Problem** instance (SMART RDF)

```xml
<sp:Problem>
  <sp:problemName>
    <sp:CodedValue>
      <dcterms:title>Backache (finding)</dcterms:title>
    </sp:CodedValue>
  </sp:problemName>
  <sp:onset>2007-06-12</sp:onset>
  <sp:resolution>2007-08-01</sp:resolution>
</sp:Problem>
```
SMART data model example

A Lab Result instance (SMART RDF)

```xml
<sp:labName>
  <sp:CodedValue>
    <dcterms:title>Serum sodium</dcterms:title>
    <sp:codeProvenance>
      <sp:CodeProvenance>
        <dcterms:title>Random blood sodium level</dcterms:title>
        <sp:translationFidelity rdf:resource="http://smartplatforms.org/terms/code/fidelity#automated"/>
      </sp:CodeProvenance>
    </sp:codeProvenance>
  </sp:CodedValue>
</sp:labName>
```
Authentication

**SMART** authenticates 1 way – using **OAuth**

*widely used web standard to delegate access*

Each HIT system authenticates its own way

**So** containers must implement **OAuth**
Substitutable Apps need

Authentication

Consistent delegation with Web standards (OAuth)
Container challenges

Mapping coding:
Medications: say NDC ➔ RxNorm
Problems: say ICD9 ➔ SNOMED CT

Mapping data concepts:
Is problem an event-at-one-time or a duration

No map for data not in Container

No map for data not in SMART, e.g., fulfillment
Incremental translation

Incremental coding *as needed to run Apps*

Local terminology – possible functional loss
Better data models?

Iterative SMART models

  Additional data types
  Richer representations
  Borrowing from outside efforts

Artifact sharing

  Participating in international CIMI group
  Need to keep app-developer focus!
SMART API principle (REST)

1 URI per patient data element
Each URI maps to *underlying* container

John Smith:
http://smart-emr.hospital.org/records/123

John Smith’s atorvastatin:
http://smart-emr.hospital.org/records/123/medications/456
Technical summary

SMART Containers supply SMART Apps with Data Authenticated API Access UI integration

Containers shoulder significant responsibility!

Data model is critical to substitutable Apps
THANK YOU!

Josh C. Mandel, MD
joshua.mandel@childrens.harvard.edu
Container UI

SMART EMR

Patient John Smith

Allergies

Labs

Meds
Container UI

SMART EMR  Patient John Smith

<table>
<thead>
<tr>
<th>Allergies</th>
<th>&lt;iframe src='http://myapp.com' /&gt;</th>
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Container UI

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cholesterol