

Substitutable Medical Applications and Reusable Technologies

Shawn Murphy MD, Ph.D.

Nich Wattanasin MS

Alyssa Porter

Stella Ubaha

Kenneth Mandl MD, MPH

Isaac Kohane MD, Ph.D.

A Related Project ...

SMART Home - Related Project - SMART - i2b2 Wiki - Windows Internet Explorer

https://community.i2b2.org/wiki/display/SMART/SMART+Home

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i2b2 WIKI SMART Home

1 Last modified on Oct 27, 2010 (view change)

i2b2 - SMART Project

As part of the [Strategic Health IT Advanced Research Projects \(SHARP\)](#) program and the [Substitutable Medical Apps Reusable Technologies \(SMART\)](#) initiative, a SMART-enabled i2b2 cell is being developed to expose a common API for SMART-applications to interact with health data within the i2b2 analytics platform.

SMART App

Core Demographics Core Meds Core Problems Core Labs Core Query

SMART Platform Instance

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Internet 100%



Questions at the beginning ..

- What is the SMART project about?
- How does SMART fit into i2b2?
- What new capabilities will i2b2 gain from this project?
- What will be added to i2b2 architecture?
- What other exciting paths could this lead us to?

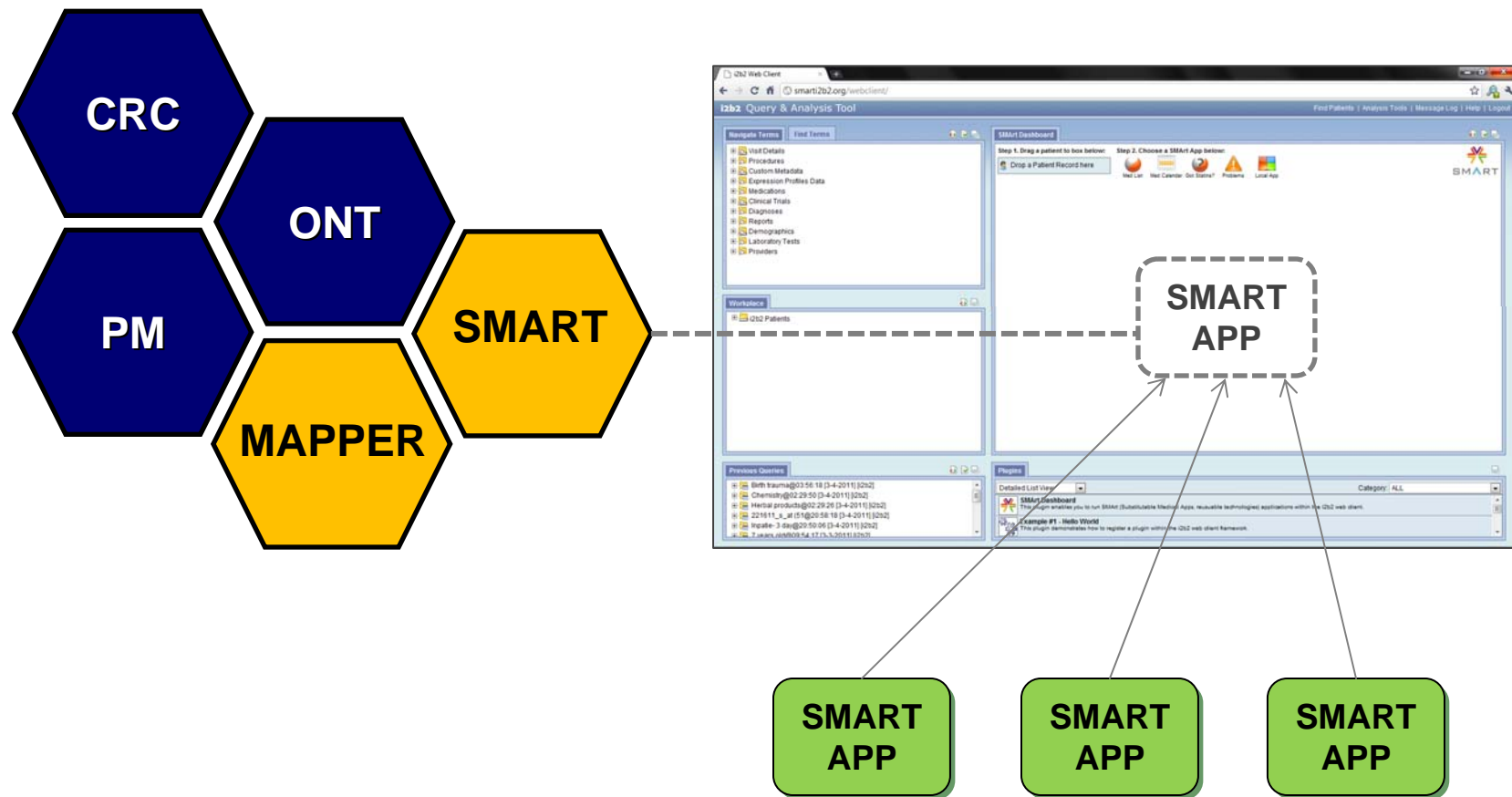
What is the SMART project about?



SMART

- Substitutable Medical Apps, reusable technologies
- Provides a unified mechanism for diverse apps to interact with medical record data – An iPad kind of App that fits into AJAX model of web browsing
- Enables **SMART Apps** built against a **SMART API** to be embedded within any **SMART Container**
- A **SMART Container** can be an EMR system used by physicians, or a PHR system used by patients...or a data-analytics platform such as **i2b2** used by researchers

How does SMART fit into i2b2?



SMART Container in i2b2

The screenshot displays the i2b2 Web Client interface, titled "i2b2 Query & Analysis Tool". The browser address bar shows "smart2b2.org/webclient/". The interface is divided into several panels:

- Top Bar:** Contains navigation links: "Find Patients", "Analysis Tools", "Message Log", "Help", and "Logout".
- Left Panel:**
 - Navigate Terms:** A tree view showing categories like "Visit Details", "Procedures", "Custom Metadata", "Expression Profiles Data", "Medications", "Clinical Trials", "Diagnoses", "Reports", "Demographics", "Laboratory Tests", and "Providers".
 - Workplace:** A section titled "i2b2 Patients" with a search bar.
 - Previous Queries:** A list of recent queries, including "Birth trauma@03:56:18 [3-4-2011] [i2b2]", "Chemistry@02:29:50 [3-4-2011] [i2b2]", "Herbal products@02:29:26 [3-4-2011] [i2b2]", "221611_s_at (51@20:58:18 [3-4-2011] [i2b2]", "Inpatie- 3 day@20:50:06 [3-4-2011] [i2b2]", and "7 years old@09:54:17 [3-3-2011] [i2b2]".
- Right Panel:**
 - SMART Dashboard:** A section with two steps: "Step 1. Drag a patient to box below:" (with a "Drop a Patient Record here" button) and "Step 2. Choose a SMART App below:" (with icons for "Med List", "Med Calendar", "Got Stats?", "Problems", and "Local App"). The SMART logo is also present.
 - Plugins:** A section showing a "Detailed List View" of installed plugins. The "SMART Dashboard" plugin is highlighted, with a description: "This plugin enables you to run SMART (Substitutable Medical Apps, reusable technologies) applications within the i2b2 web client." Below it, "Example #1 - Hello World" is listed with the description: "This plugin demonstrates how to register a plugin within the i2b2 web client framework."

SMART Container in i2b2

The screenshot displays the i2b2 Web Client interface, which is a web-based tool for querying and analyzing medical data. The interface is divided into several sections:

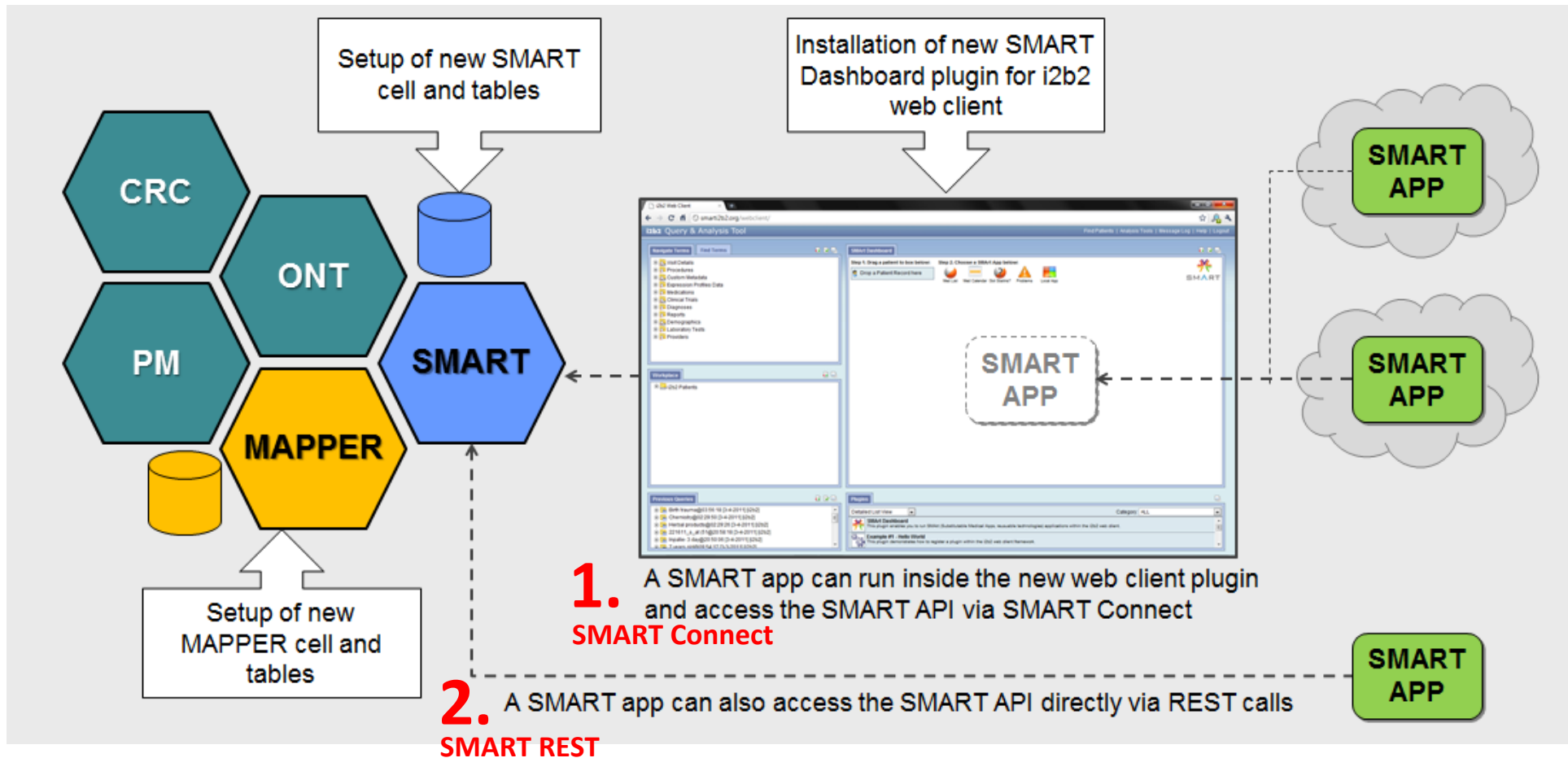
- Header:** The top bar includes the text "i2b2 Query & Analysis Tool" and navigation links: "Find Patients | Analysis Tools | Message Log | Help | Logout".
- Navigate Terms:** A sidebar on the left lists various data categories: Visit Details, Procedures, Custom Metadata, Expression Profiles Data, Medications, Clinical Trials, Diagnoses, Reports, Demographics, Laboratory Tests, and Providers.
- Workplace:** A section below the sidebar lists "i2b2 Patients" with a list of patient IDs (e.g., PATIENT:1000000001, PATIENT:1000000002, etc.).
- Previous Queries:** A section at the bottom left shows a list of recent queries, including "Birth trauma@03:56:18 [3-4-2011] [i2b2]", "Chemistry@02:29:50 [3-4-2011] [i2b2]", "Herbal products@02:29:26 [3-4-2011] [i2b2]", "221611_s_at (51@20:58:18 [3-4-2011] [i2b2]", "Inpatie- 3 day@20:50:06 [3-4-2011] [i2b2]", and "7 years old@09:54:17 [3-3-2011] [i2b2]".
- SMART Dashboard:** The main area on the right is titled "SMART Dashboard". It contains a "Step 1. Drag a patient to box below:" section with a text input field containing "PATIENT:1000000008". To the right of this is a "Step 2. Choose a SMART App below:" section with icons for "Med List", "Med Calendar", "Got Stats?", "Problems", and "Local App". Below these steps is a "Prescriptions" section with a table of medication data.

The "Prescriptions" table has the following columns: Name, Start Date, Est. End Date, and Instructions. The data rows are as follows:

| Name | Start Date | Est. End Date | Instructions |
|---|-----------------|-----------------|--------------|
| 100 ACTUAT Beclomethasone Dipropionate 0.08 MG/ACTUAT Metered Dose Inhaler [Qvar] | Thu Apr 04 2002 | Sun Apr 04 2004 | |
| 200 ACTUAT Ipratropium Bromide 0.018 MG/ACTUAT Metered Dose Inhaler [Atrovent] | Thu Apr 04 2002 | Sun Apr 04 2004 | |
| 200 ACTUAT Ipratropium Bromide 0.018 MG/ACTUAT Metered Dose Inhaler [Atrovent] | Wed Jul 17 2002 | Sat Jul 17 2004 | |
| Acetaminophen 24 MG/ML / Codeine Phosphate 2.4 MG/ML Oral Solution | Thu Aug 27 2009 | Sat Aug 27 2011 | |
| Cyclobenzaprine hydrochloride 10 MG | Thu Aug 27 2009 | Sat Aug 27 2011 | |

At the bottom right, there is a "Plugins" section with a "Detailed List View" and a "Category: ALL" dropdown. It lists two plugins: "SMART Dashboard" (which enables running SMART applications) and "Example #1 - Hello World" (which demonstrates plugin registration).

Message Architecture: SMART i2b2 Cell (REST & OAuth)



1. SMART Connect

i2b2 Query & Analysis Tool

Find Patients | Analysis Tools | Message Log | Help | Logout

Navigate Terms

Find Terms

- Visit Details
- Procedures
- Custom Metadata
- Expression Profiles Data
- Medications
- Clinical Trials
- Diagnoses
- Reports
- Demographics
- Laboratory Tests
- Providers

Workplace

- i2b2 Patients

Previous Queries

- CT Re- 35--Appen@16:27:27 [6-10-2011] [i2b2]
- 18-34-Female@16:21:04 [5-26-2011] [i2b2]
- Clove@02:25:41 [5-14-2011] [i2b2]
- Clove@18:57:20 [5-9-2011] [i2b2]
- Cerebrovascular@17:40:45 [4-21-2011] [i2b2]
- Hymersk-Prodnc@20:30:12 [4-4-2011] [i2b2]

SMART Dashboard

Step 1. Drag a patient to box below:

Drop a Patient Record here

Step 2. Choose a SMART App below:

- Med List
- Med Calendar
- Got Statins?
- Problems
- Cardiac Risk
- Local App



Load a SMART app
using SMART
Connect

New "SMART
Dashboard" i2b2
web client plug-in

Plugins

Detailed List View

Category: ALL



SMART Dashboard

This plugin enables you to run SMART (Substitutable Medical Apps, reusable technologies) applications within the i2b2 web client.



Example #1 - Hello World

This plugin demonstrates how to register a plugin within the i2b2 web client framework.

1. SMART Connect

i2b2 Query & Analysis Tool

Find Patients | Analysis Tools | Message Log | Help | Logout

Navigate Terms

Find Terms

- Visit Details
- Procedures
- Custom Metadata
- Expression Profiles Data
- Medications
- Clinical Trials
- Diagnoses
- Reports
- Demographics
- Laboratory Tests
- Providers

Workplace

- i2b2 Patients
 - 1000000008 [23 y/o M hispanic]
 - 1000000059 [35 y/o M hispanic]
 - PATIENT:1000000001
 - PATIENT:1000000002
 - PATIENT:1000000003
 - PATIENT:1000000004
 - PATIENT:1000000005
 - PATIENT:1000000006
 - PATIENT:1000000007
 - PATIENT:1000000008
 - PATIENT:1000000009
 - PATIENT:1000000010
 - PATIENT:1000000011
 - PATIENT:1000000012
 - PATIENT:1000000013

Previous Queries

- CT Re- 35--Appen@16:27:27 [6-10-2011] [i2b2]
- 18-34-Female@16:21:04 [5-26-2011] [i2b2]
- Clove@02:25:41 [5-14-2011] [i2b2]
- Clove@18:57:20 [5-9-2011] [i2b2]
- Cerebrovascular@17:40:45 [4-21-2011] [i2b2]
- Hypertension@20:30:12 [4-4-2011] [i2b2]

SMART Dashboard

Step 1. Drag a patient to box below:

1000000008 [23 y/o M hispanic]

Step 2. Choose a SMART App below:



Bloodwork Cardiology Result

Note: these results are valid for non-diabetics

Patient info

NAME: i2b2 Patient Num 1000000008

GENDER: M AGE: 45 DOB: 1986-12-16

120

☐ Current smoker?

☐ Family history of heart attack?

Systolic blood pressure

1 About this test

This report evaluates your potential risk of heart disease, heart attack, and stroke.

2 Your Results

Cholesterol level test

0.20



Low risk 0 mg/L Average 1-3 High risk of cardiovascular disease 3-10

Total cholesterol level



Desirable 0 mg/dL Borderline 200-239 High 240+

LDL "bad" cholesterol



130

100

Plugins

Detailed List View

Category: ALL



SMART Dashboard

This plugin enables you to run SMART (Substitutable Medical Apps, reusable technologies) applications within the i2b2 web client.



Example #1 - Hello World

This plugin demonstrates how to register a plugin within the i2b2 web client framework.

2. SMART REST

A SMART app can access a resource directly via REST URLs:

`http://smarti2b2.org/records/100000012/medications/`

- App sends its OAuth credentials in Authorization part of request to the SMART cell

```
GET /records/100000012/medications/ HTTP/1.1
Host: smarti2b2.org
Authorization: OAuth realm="SMART",
    oauth_consumer_key="dpf43f3p214k3101",
    oauth_token="nnch734d00s12jdk",
    oauth_signature_method="HMAC-SHA1",
    oauth_timestamp="123456789",
    oauth_nonce="JKFJxn",
    oauth_signature="MdpQcU8iPSUjWoN%2FUDMsK2sui9I%3D"
```

Currently, not all SMART REST apps will work against i2b2 without further configuration. The REST apps currently make reference to the Sandbox environment at smartplatforms.org with their usable tokens. REST apps can be configured to work in i2b2, though, like RxMinder.

[Find Patients](#) | [Analysis Tools](#) | [Message Log](#) | [Help](#) | [Logout](#)

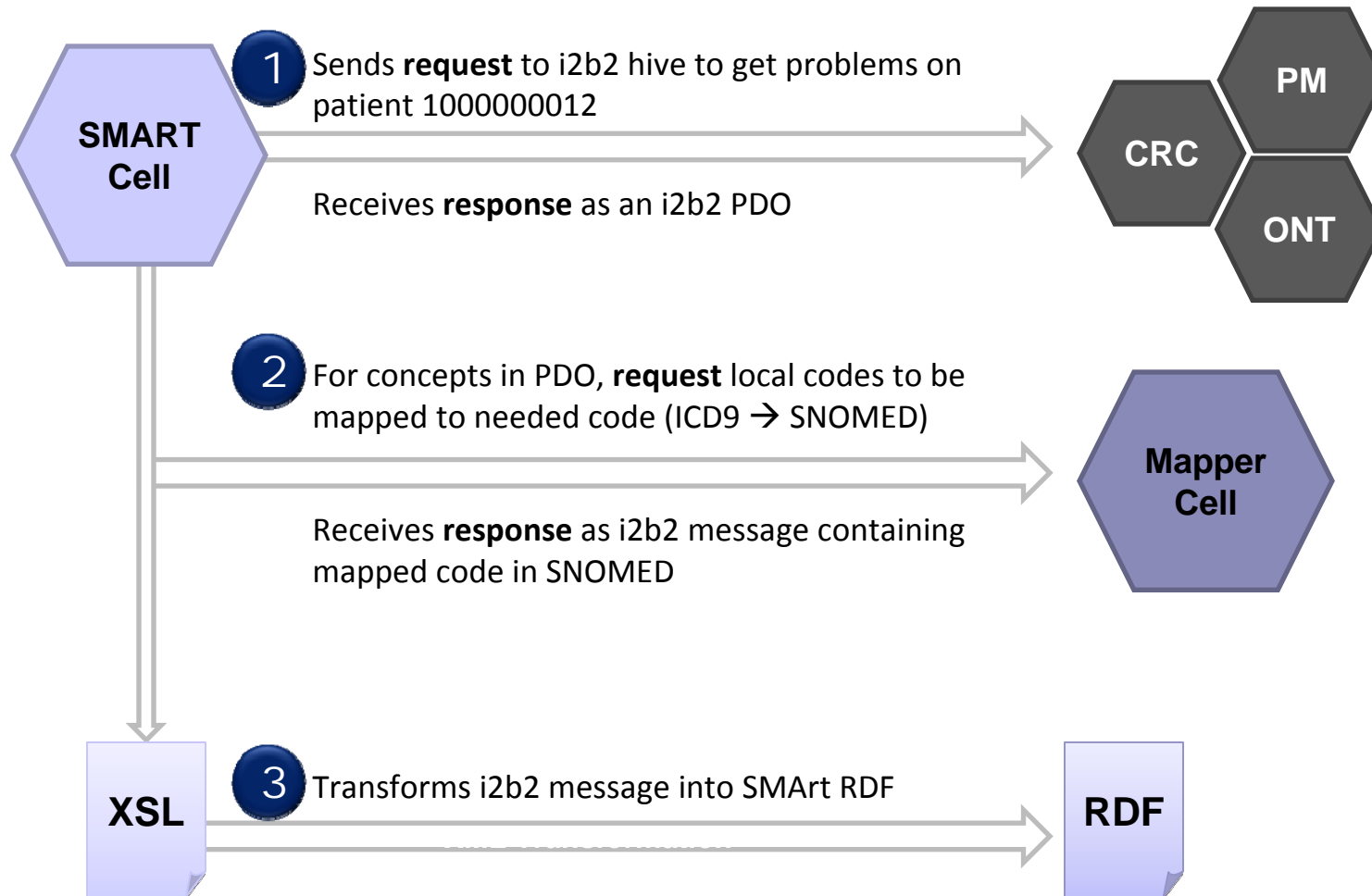
This plugin demonstrates how to register a plugin within the i2b2 web client framework.

- 
- Demo by Nich Wattanasin
 - <http://smarti2b2.org/>

What new capabilities will i2b2 gain from this project?

- **Recruit Patients for Clinical Trials – Capitalizing on SMART**
- Find cohort and save patient set
- Create a project for the study
- Review patients one by one in the project
 - Need contact demographics
 - Need patient-by-patient optimized views
 - May need very current enterprise data
- Coordinating center manages and recruits patient by institutions set of rules

What will be added to the i2b2 architecture?



Messages

1. An individual's problems as represented in an i2b2 XML message:

```
- <ns2:concept_set>
- <concept>
  <concept_path>\i2b2\Diagnoses\Circulatory system (390-459)\Hypertensive disease (401-405)\(401)
    Essential hypertension\ (401-9) Unspecified essential hyp~\</concept_path>
  <concept_cd>ICD9:401.9</concept_cd>
  <name_char>Huchard's disease</name_char>
</concept>
- <concept>
  <concept_path>\i2b2\Diagnoses\Digestive system (520-579)\Oral cavity diseases (520-529)\(523)
    Gingival and periodontal di~\ (523-6) Accretions on teeth\</concept_path>
  <concept_cd>ICD9:523.6</concept_cd>
  <name_char>Dental plaque</name_char>
</concept>
- <concept>
  <concept_path>\i2b2\Diagnoses\Digestive system (520-579)\Oral cavity diseases (520-529)\(523)
    Gingival and periodontal di~\ (523-9) Unspecified gingival and ~\</concept_path>
  <concept_cd>ICD9:523.9</concept_cd>
  <name_char>Unspecified gingival and periodontal disease</name_char>
</concept>
- <concept>
  <concept_path>\i2b2\Diagnoses\Genitourinary system (580-629)\Nephritis, nephrotic syndrome, and
    nephrosis (580-589)\(585) Chronic renal failure\</concept_path>
  <concept_cd>ICD9:585</concept_cd>
  <name_char>Chronic renal failure</name_char>
</concept>
```

Ontology
Cell

Case: We require diagnoses to be coded in SNOMED, but we only have ICD9 codes.

Action: Send an XML request to the Mapping Cell with the desired ICD9's (above) to be mapped to SNOMED (e.g. ICD9: 401.9)

2. Response from Mapping Cell contains SNOMED codes and names:

```
- <mapped_concept_set>
- <mapping>
  <source_coding_system>ICD9</source_coding_system>
  <source_basecode>401.9</source_basecode>
  <destination_coding_system>SNO</destination_coding_system>
  <destination_basecode>38341003</destination_basecode>
  <destination_name>Hypertensive disorder, systemic arterial (disorder)</destination_name>
</mapping>
- <mapping>
  <source_coding_system>ICD9</source_coding_system>
  <source_basecode>523.6</source_basecode>
  <destination_coding_system>SNO</destination_coding_system>
  <destination_basecode>17552000</destination_basecode>
  <destination_name>Dental calculus (disorder)</destination_name>
</mapping>
- <mapping>
  <source_coding_system>ICD9</source_coding_system>
  <source_basecode>523.9</source_basecode>
  <destination_coding_system>SNO</destination_coding_system>
  <destination_basecode>2556008</destination_basecode>
  <destination_name>Periodontal disease (disorder)</destination_name>
</mapping>
- <mapping>
  <source_coding_system>ICD9</source_coding_system>
  <source_basecode>585</source_basecode>
  <destination_coding_system>SNO</destination_coding_system>
  <destination_basecode>90688005</destination_basecode>
  <destination_name>Chronic renal failure syndrome (disorder)</destination_name>
</mapping>
```

Mapping
Cell

The mapping cell returned the mappings for the ICD9's sent from the previous slide (e.g. SNOMED of **38341003** mapped to ICD9: 401.9)

3. i2b2 “Mapped PDO” is transformed into RDF in SMarT Cell

```
- <sp:Problem>
- <sp:problemName>
- <sp:CodedValue>
  <sp:code rdf:resource="http://www.ihtsdo.org/snomed-ct/concepts/38341003/" />
  <dcterms:title>Hypertensive disorder, systemic arterial (disorder)</dcterms:title>
- <sp:codeProvenance>
  - <sp:CodeProvenance>
    <sp:sourceCode rdf:resource="http://smart.i2b2.org/concepts/code#ICD9:401.9" />
    <dcterms:title>Huchard's disease</dcterms:title>
    <sp:translationFidelity rdf:resource="http://smartplatforms.org/terms/code/fidelity#automated" />
  </sp:CodeProvenance>
</sp:codeProvenance>
</sp:CodedValue>
</sp:problemName>
<sp:onset>2005-10-31</sp:onset>
<sp:resolution>2007-10-31</sp:resolution>
</sp:Problem>
```

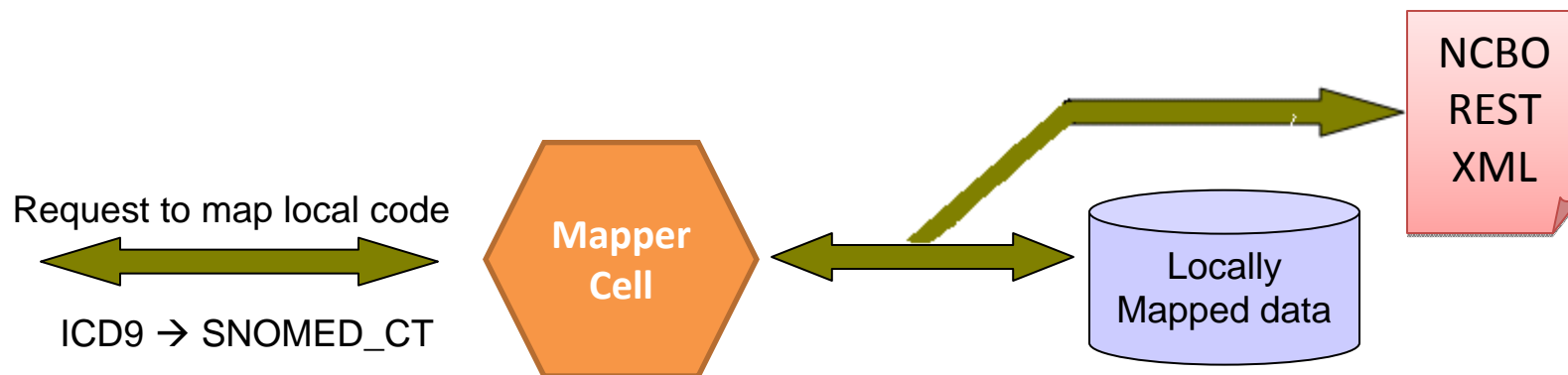
SMarT
Cell

Providing mappings using NCBO services

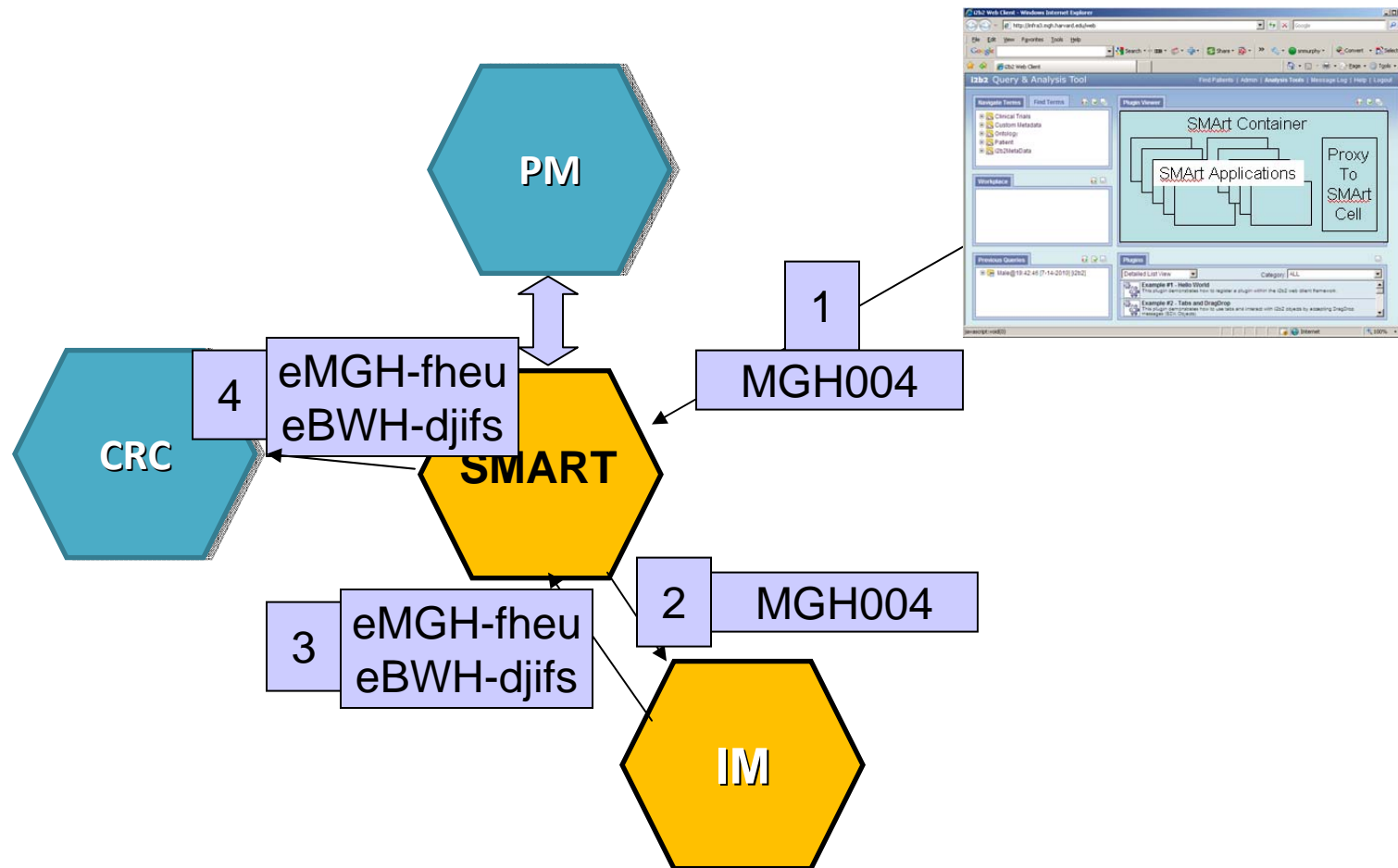
■ Mapping cell

- Need for mapping different site-specific ontologies in cross-institutional settings. (SNOMED_CT ↔ ICD-9, RxNORM ↔ NDC)
- First look for locally mapped data
- Then seek mappings through NCBO services.

<http://bioportal.bioontology.org/mappings/service/1101/>



Workflow stimulates development of IM Cell

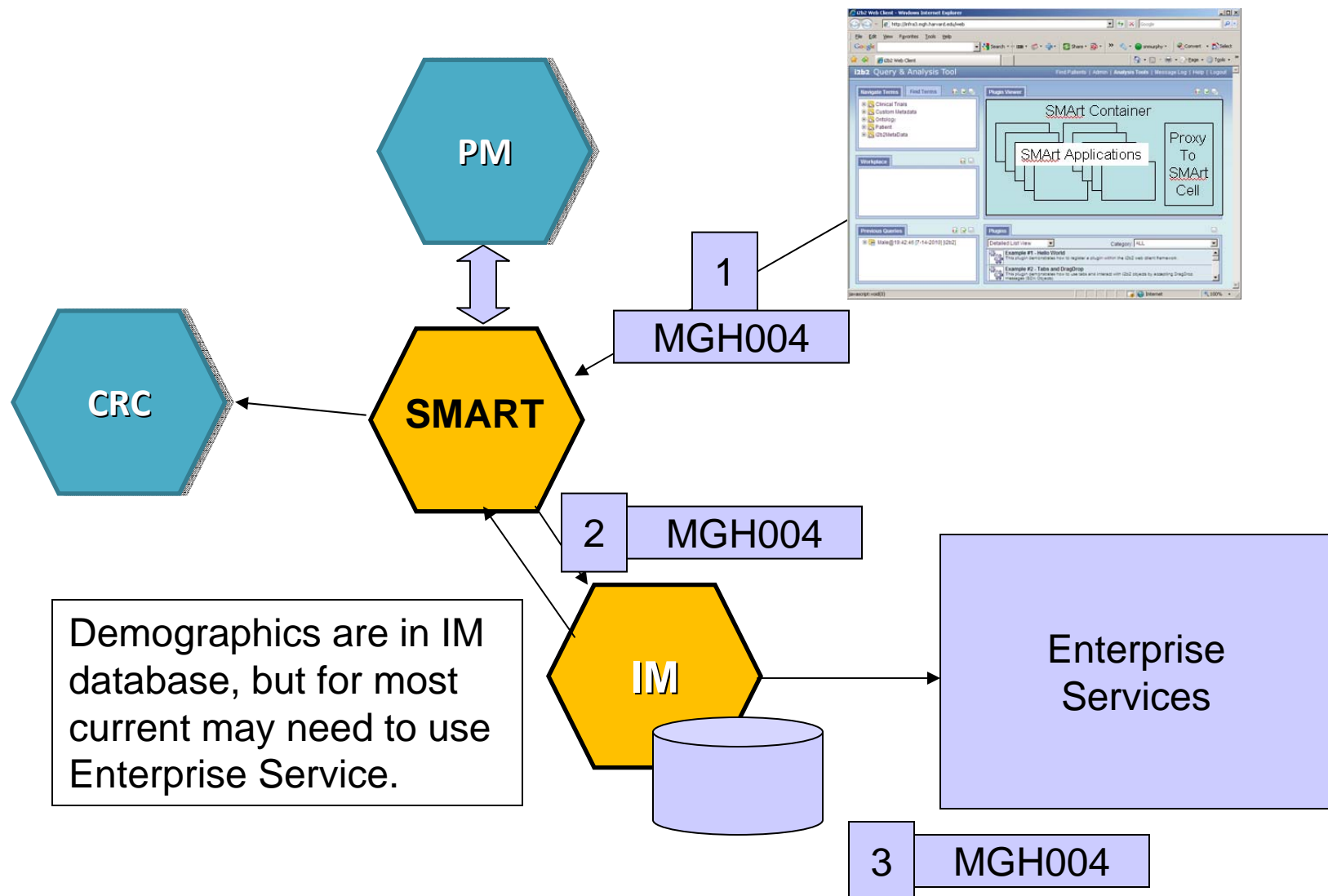


Identity Management Cell

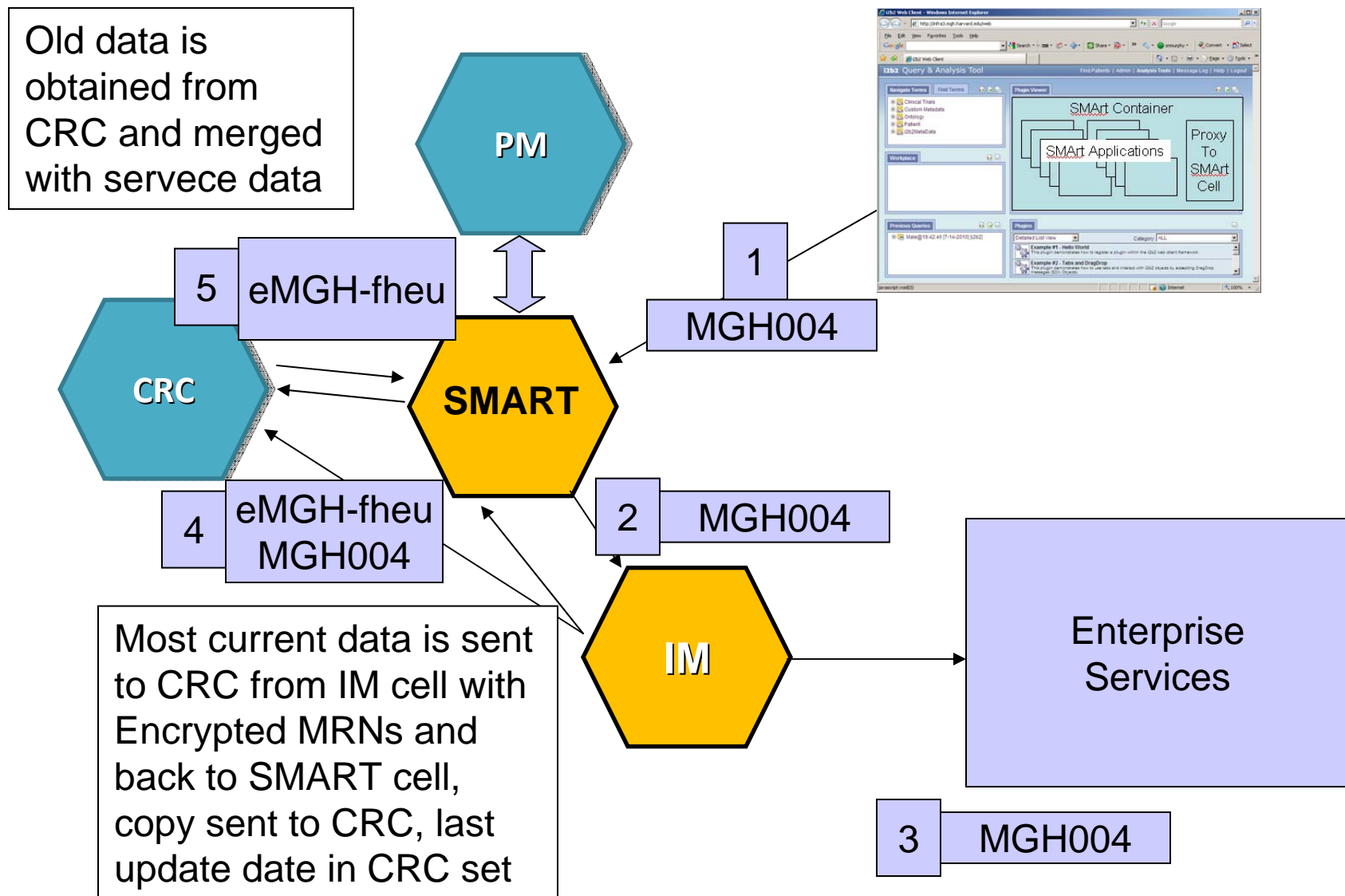
■ Main functions

- Converts MRNs to i2b2 patient nums
- Holds demographics in tables which themselves do not contain clinical data
- Links to enterprise services and converts custom enterprise output to i2b2 standards
- Lists of patients with real identifiers are managed and linked to a project

Introduction of demographics into IM cell

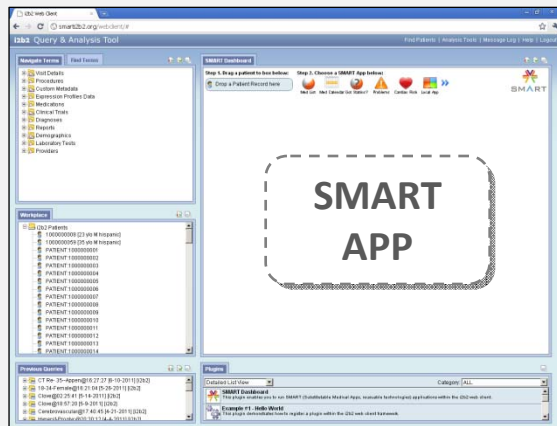


ETL of hospital services through IM Cell

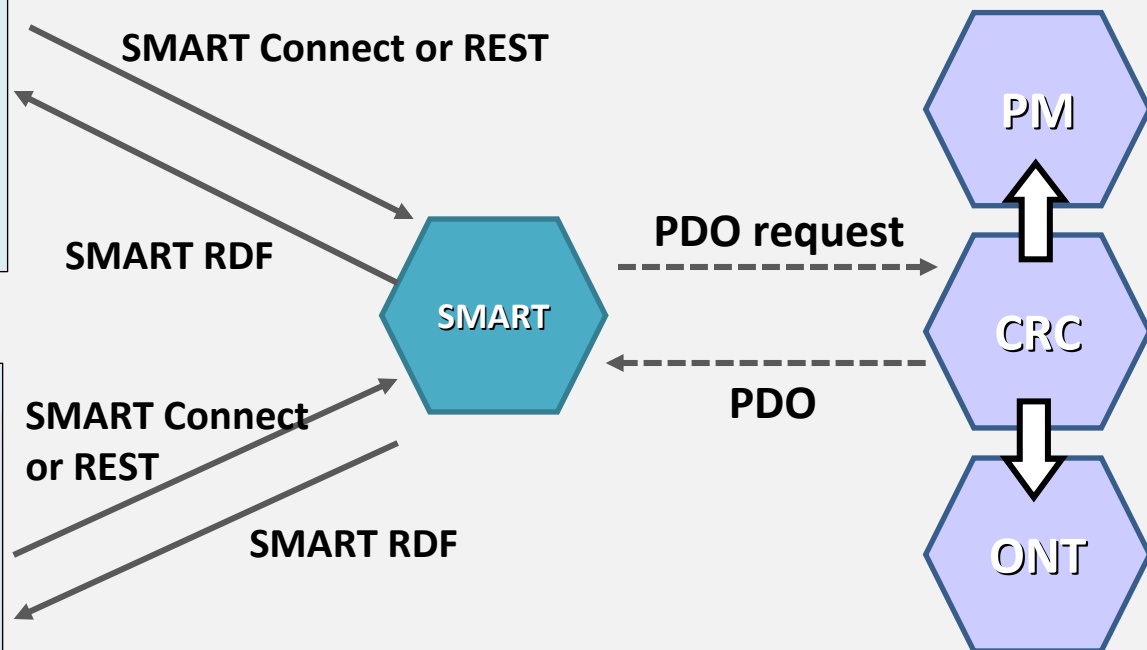
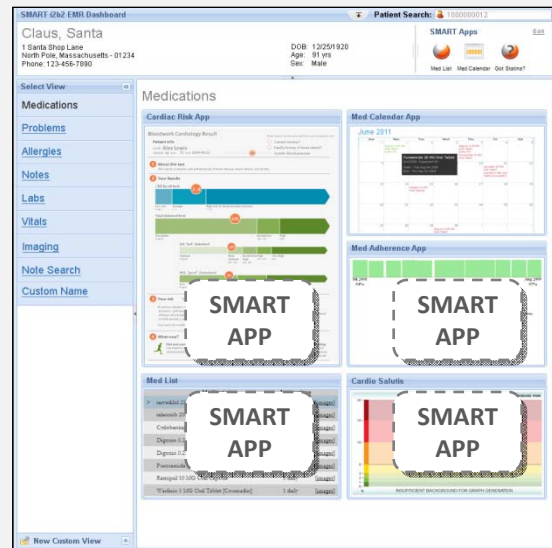


Client can be optimized for EMR-View of patient

i2b2 web client



SMART EMR-View client

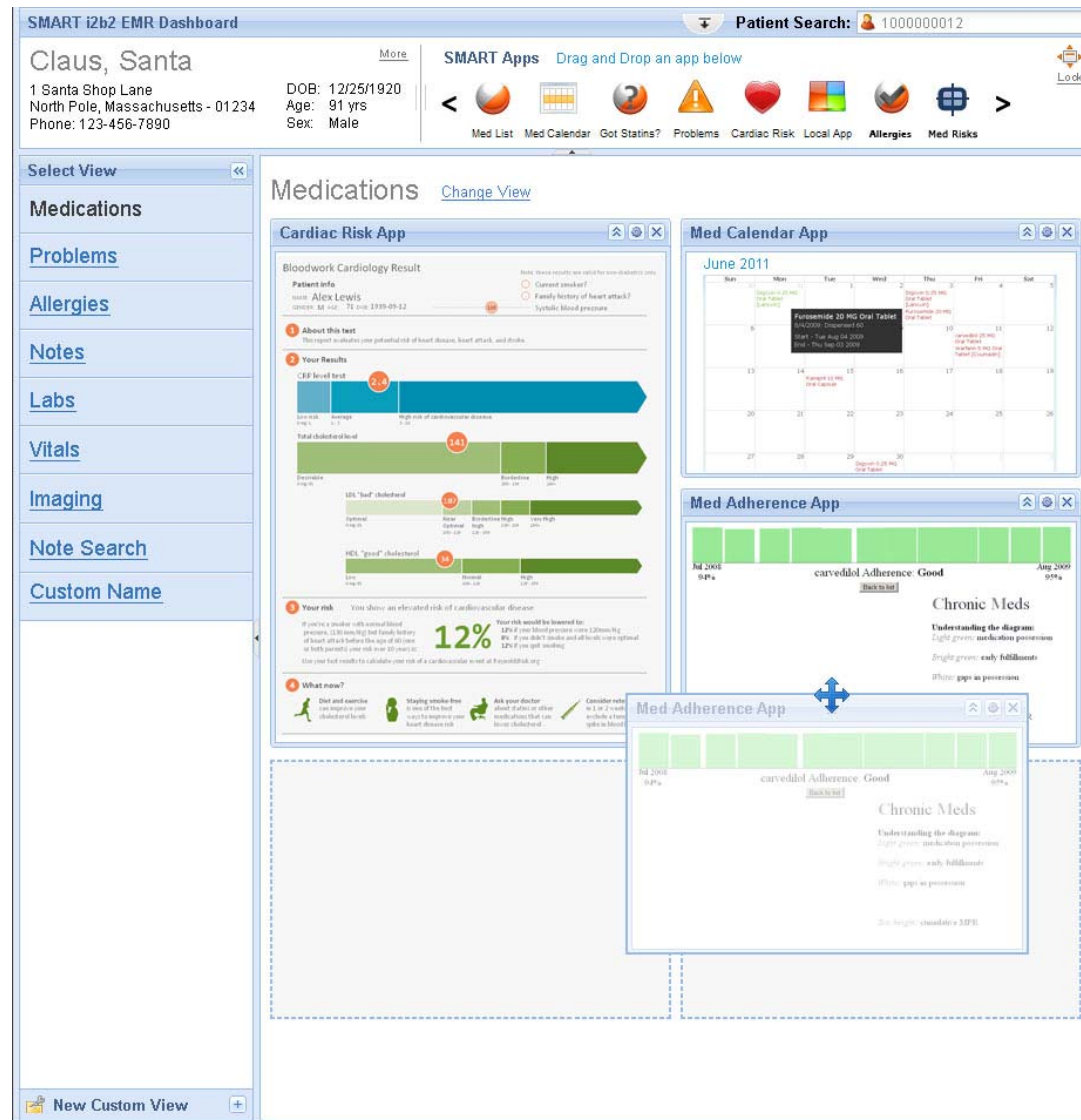


The job of the SMART cell is to do most of the heavy lifting to convert SMART queries into serviceable i2b2 queries and convert i2b2 responses to SMART RDF responses that can be consumed by the SMART apps.

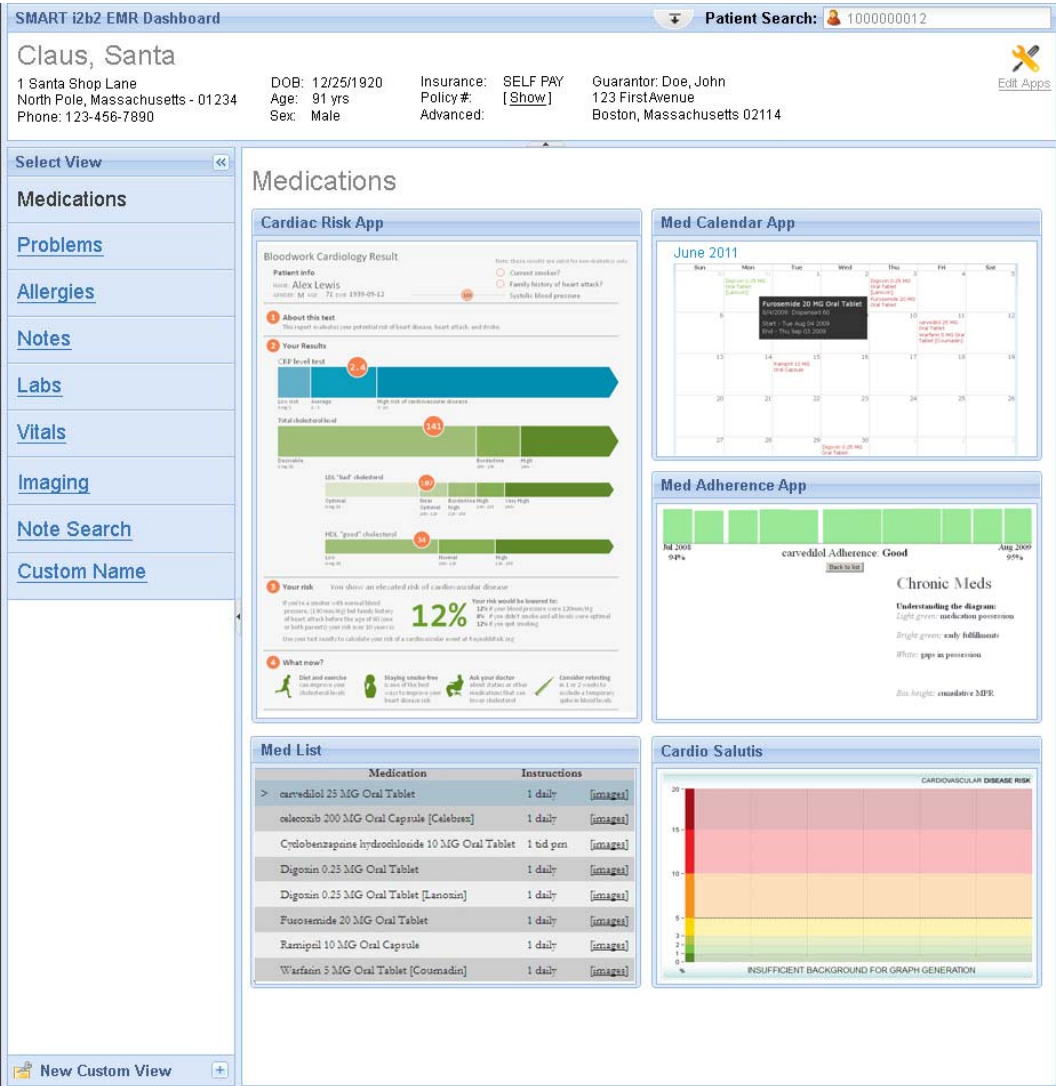
What other exciting paths could this lead us to?

- Create a client to optimize EMR-View of patient
- Allow recruitment across several sites with common coordinating center
 - Find cohort
 - Recruit doctors at other institutions for a clinical trial
 - Create a project for the study
 - Present patients one by one using SHRINE data + contact demographics
 - Institutions may want to enforce quotas and slowly release patient data to keep contributions of patients to the clinical trial even across sites
 - Coordinating center manages and recruits patient by each institutions set of rules

| Response | Count |
|----------|-------|
| No | 1 |
| Yes | 1 |



| Category | Percentage |
|-------------------|------------|
| Top Bar (Gray) | ~95% |
| Bottom Bar (Blue) | ~95% |



Layout of Patient Lookup

SMART i2b2 EMR Dashboard

Patient Search: 1000000012

Claus, Santa
1 Santa Shop Lane
North Pole, Massachusetts - 01234
Phone: 123-456-7890

DOB: 12/25/1920
Age: 91 yrs
Sex: Male

SMART Apps Drag and Drop an app below

Med List Med Calendar Got Status? Problems Cardiac Risk Local App Allergies Med Risks

Select View

Today's Upcoming Patients

| Time | Patient Name | Appointment | Gender | Date |
|----------|------------------------|-----------------|--------|----------|
| 9:30 AM | Merico, Julia S. | Pain in neck | 31/F | 3/17/79 |
| 10:00 AM | Frank, Bowler M. | Abdominal pain | 42/F | 12/21/69 |
| 10:30 AM | Nadeau, Leslie | General checkup | 35/F | 8/5/75 |
| 11:00 AM | Stevens, Scott | Pink eye | 28/M | 6/8/84 |
| 11:30 AM | Howser, Andrew | General checkup | 31/M | 3/12/79 |
| 12:00 PM | Bogalino, Roy Antho... | Sore throat | 24/M | 1/30/85 |
| 12:30 PM | Spago, Stephanie | Twisted ankle | 19/F | 12/12/89 |
| 1:00 PM | Hyde, Samal | Broken arm | 27/M | 9/7/82 |
| 9:30 AM | Merico, Julia S. | Pain in neck | 31/F | 3/17/79 |
| 10:00 AM | Frank, Bowler M. | Abdominal pain | 42/F | 12/21/69 |
| 10:30 AM | Nadeau, Leslie | General checkup | 35/F | 8/5/75 |
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| 12:30 PM | Spago, Stephanie | Twisted ankle | 19/F | 12/12/89 |
| 1:00 PM | Hyde, Samal | Broken arm | 27/M | 9/7/82 |

Search

ABCDEFGHIJKLMNOPQRSTUVWXYZ

B by Last Name

SSN

Chart Number

Results

| name | ssn | chart number | phone | patient |
|-------------------|-------------|--------------|----------------|--------------|
| Barich, Kara | 123-45-9017 | 66375 | (305) 879-4783 | data - chart |
| Bartolick, Carrie | 132-66-8518 | 55192 | (305) 227-0362 | data - chart |
| Beard, Scott | 123-45-8972 | 47385 | (786) 681-8202 | data - chart |
| Bertsch, Susan | 132-66-8538 | 63632 | (786) 750-7081 | data - chart |
| Black, Steve | 123458956 | 57513 | (786) 380-8043 | data - chart |
| Bogoslawsky, Bob | 132-66-8513 | 53082 | (305) 222-0312 | data - chart |
| Bontempi, Joanne | 123-45-9011 | 63843 | (786) 760-6135 | data - chart |
| Booker, John | 123-45-8998 | 58357 | (786) 540-4059 | data - chart |
| Bouchillon, Steve | 132-66-8526 | 58568 | (786) 580-3063 | data - chart |
| Breed, Caroline | 123-45-9005 | 61311 | (786) 641-7487 | data - chart |
| Brown, Steven | 132-66-8541 | 64898 | (786) 810-1405 | data - chart |
| Browne, Brad | 132-66-8504 | 49284 | (305) 204-0132 | data - chart |

New Custom View

THANK YOU - URL's

- <http://smarti2b2.org/webclient/>
 - [HTML5 = IE8+, Firefox3+, Chrome]
- http://wiki.chip.org/smart-project/index.php/Main_Page
- <http://www.smartplatforms.org/>