PARTNERS HEALTHCARE

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AND MASSACHUSETTS GENERAL HOSPITAL

Query Health: standards-based, cross-platform population health surveillance

Jeffrey Klann, PhD; Michael D Buck, PHD;
Jeffrey Brown, PhD; Marc Hadley, PhD; Richard Elmore, MA;
Griffin M Weber, MD, PhD; Shawn N Murphy, MD, PhD

MGH Laboratory of Computer Science

Outline

- **Introduction**
  - **Background**
  - **Objective**
- Materials and Methods
- Results
  - Implementation
  - Pilots
- Discussion
  - Future Directions

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What is a Learning Health System?

- "The increased complexity of health care requires a sustainable system that gets the right care to the right people when they need it, and then captures the results for improvement. The nation needs a healthcare system that learns." – *Institute of Medicine, "The Learning Healthcare System"*

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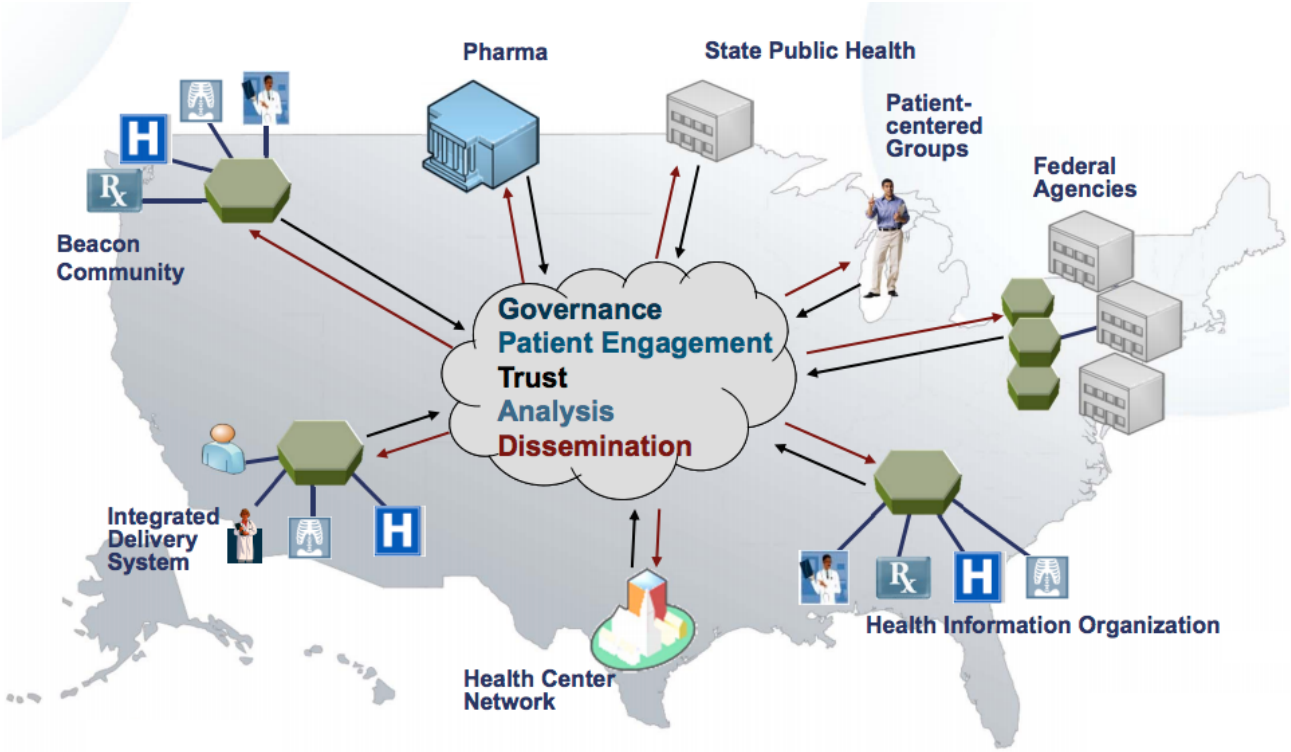
What is a Learning Health System?



- Population Health Surveillance
- Improve care quality
- Post-market drug surveillance
- Comparative Effectiveness Research
- Dissemination of Evidence Based Medicine

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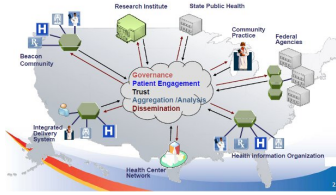
What is a Learning Health System?

- Meaningful Use is an initial step toward LHS
  - Encourages adoption and use of EHR
- Query Health is a large-scale test of LHS functionality
  - Public-private collaboration
  - Developed standards and services to enable distributed, secure, standards-based population health measurement.
  - Distributed query model
    - Brings questions to the data and returns only minimum necessary information
  - “Query Health makes health data useful.”



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Objective

- Define a **methodology** for distributed, secure, standards-based clinical queries.
- Develop a **reference implementation** using best-of-breed technological components.
- Implement components of this reference implementation at three **pilot sites**, to gauge the effectiveness of Query Health in real-world healthcare scenarios.

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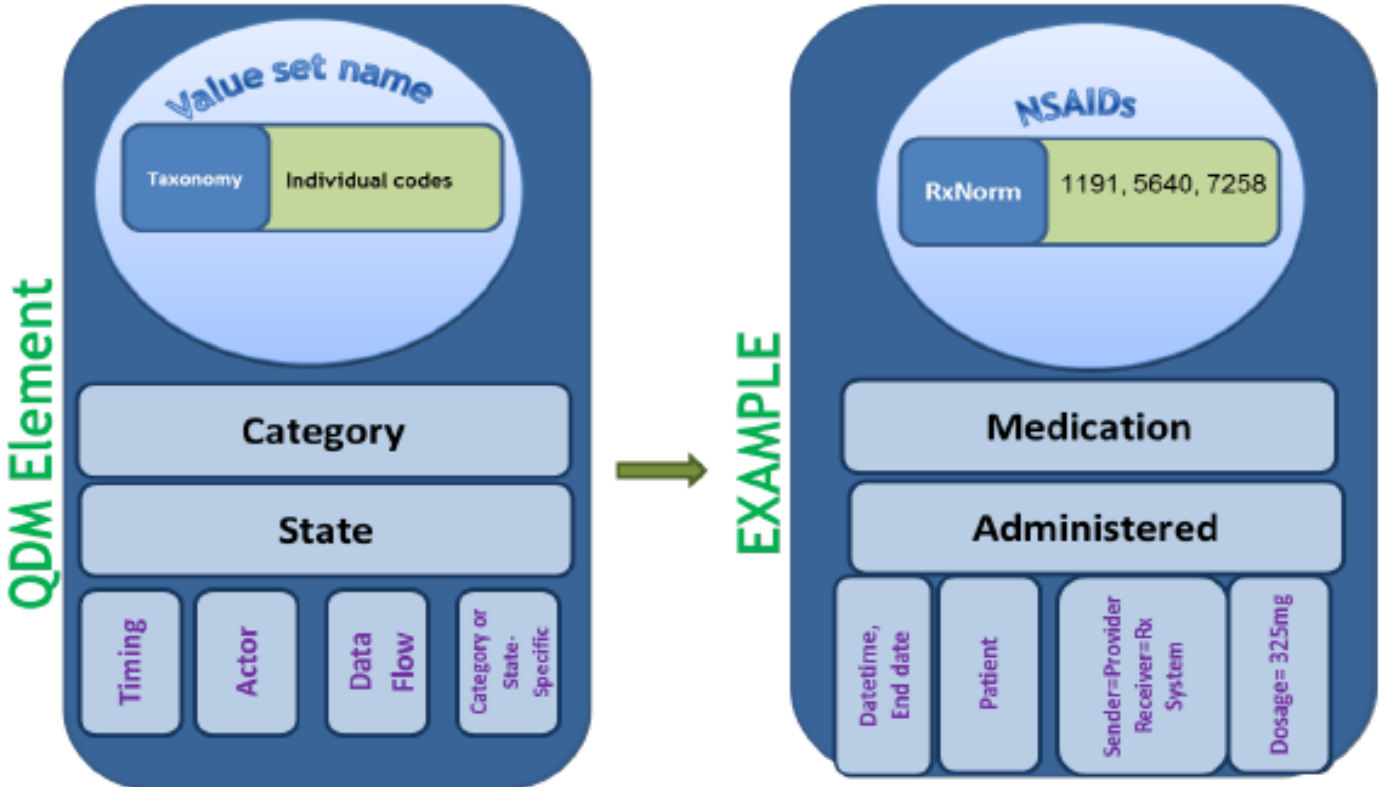
Query Health Ontology

- C-CDA based instantiation of the National Quality Forum's Quality Data Model



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Query Health Ontology

- C-CDA based instantiation of the National Quality Forum's Quality Data Model

C-CDA

MU2 CCD Profile

- Demographics
- Vitals
- Current List Of…
  - Problems
  - Medications
  - Allergies
  - Immunizations
- Procedures
- Family History
- Plan of Care
- Smoking, cognitive, and functional status

…

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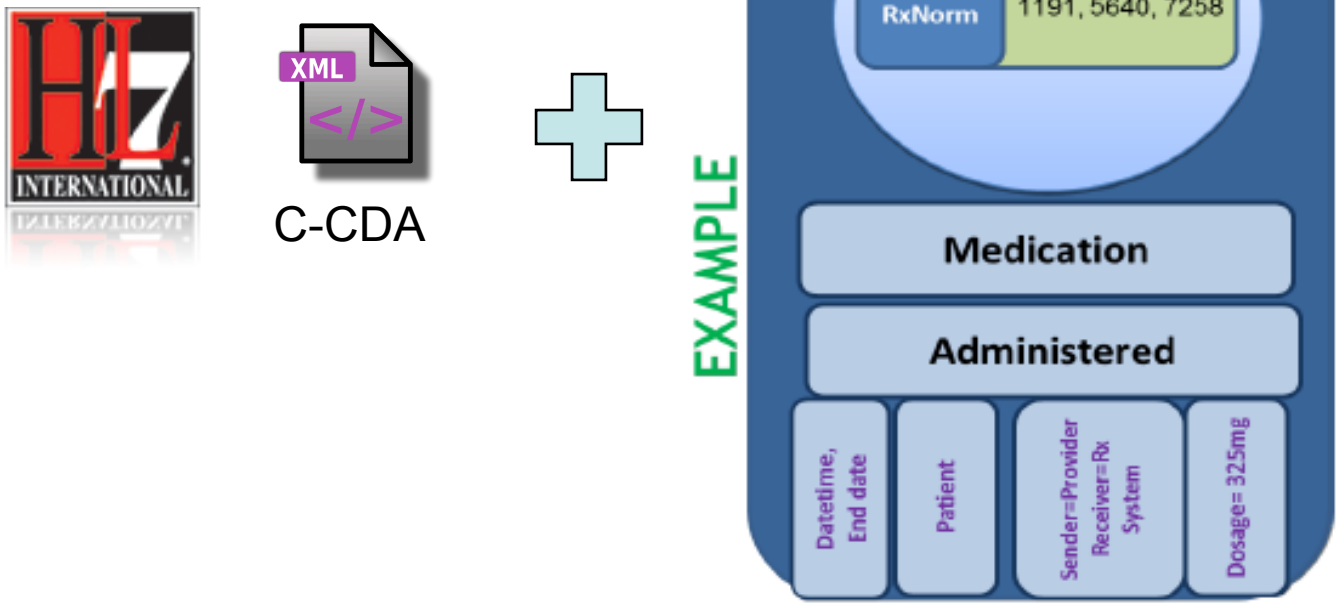

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Query Health Ontology

- Demographic
- Patient Contact Information
- Payer Information
- Healthcare Provider
- Allergies & Adverse Reactions
- Encounter
- Surgery
- Diagnosis
- Medication
- Procedure
- Immunization

  - Advance Directive
  - Vital Signs
  - Physical Exam
  - Family History
  - Social History
  - Order
  - Result
  - Medical Equipment
  - Care Setting
  - Enrollment
  - Facility

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Query Format

National Quality Forum

113 CQMs

93 MU2 CQMs

HQMF

Health Quality Measures Format

S&I

HL7 INTERNATIONAL

HQMFr2 Revision

Klann JG, Murphy SN. *Computing Health Quality Measures Using Informatics for Integrating Biology and the Bedside*. J Med Internet Res 2013

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Anatomy of an HQMF query

- NQF 0059: Uncontrolled diabetes
  - The number of diabetes patients between 18-75 who have had a hemoglobin A1C test greater than 9% in the past year

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Anatomy of an HQMF query

- **The Measure Period:** 1 year
- **The Data Criteria**
  - 18-75 years old [AGE]
  - Diabetes diagnosis [DX]
  - Diabetes medication [MED]
  - HgbA1C>9 [A1C]
- **The Population Criteria**
  - All Of:
    - AGE
    - A1C
    - At least one of:
      - DX
      - MED

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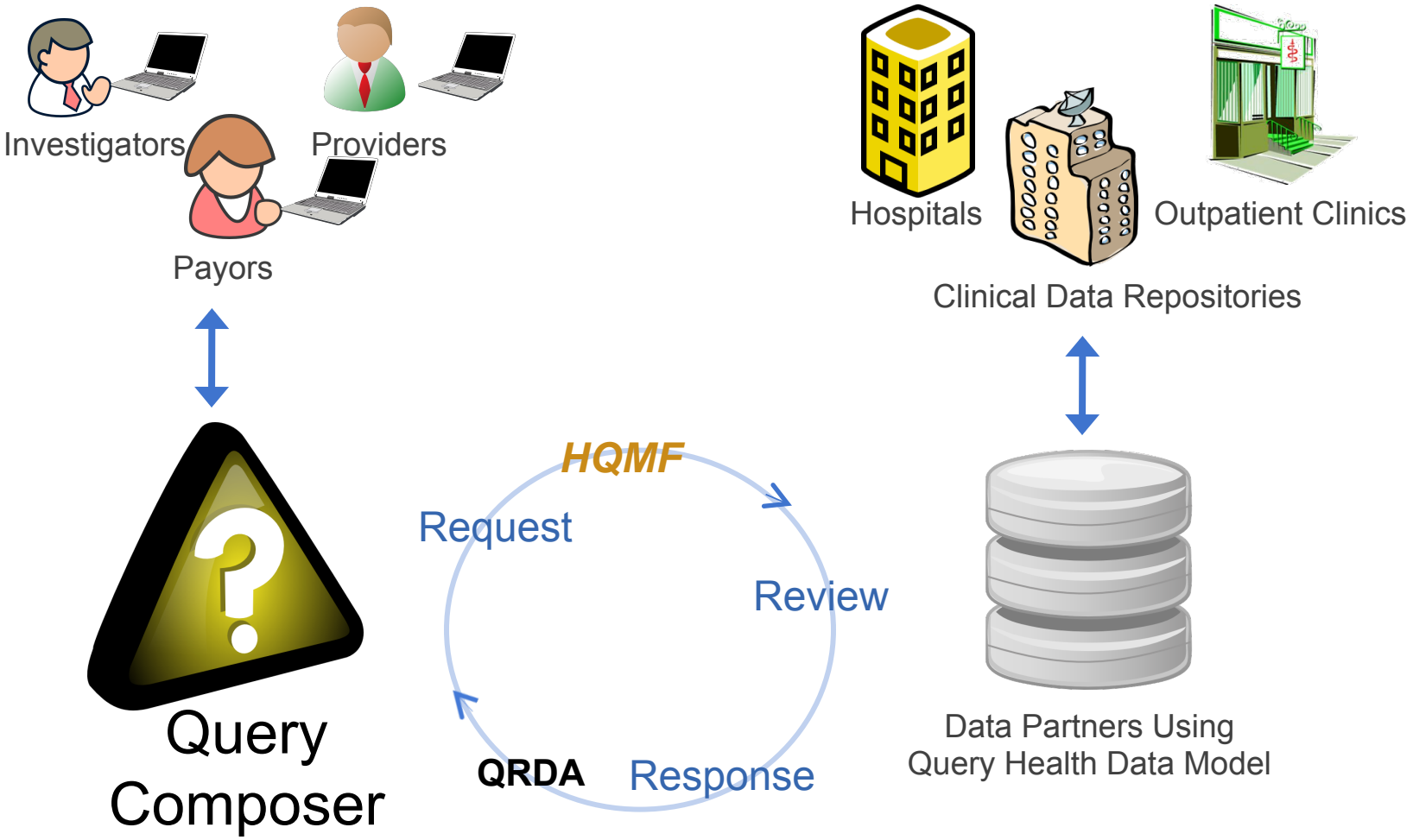
Query Health Design



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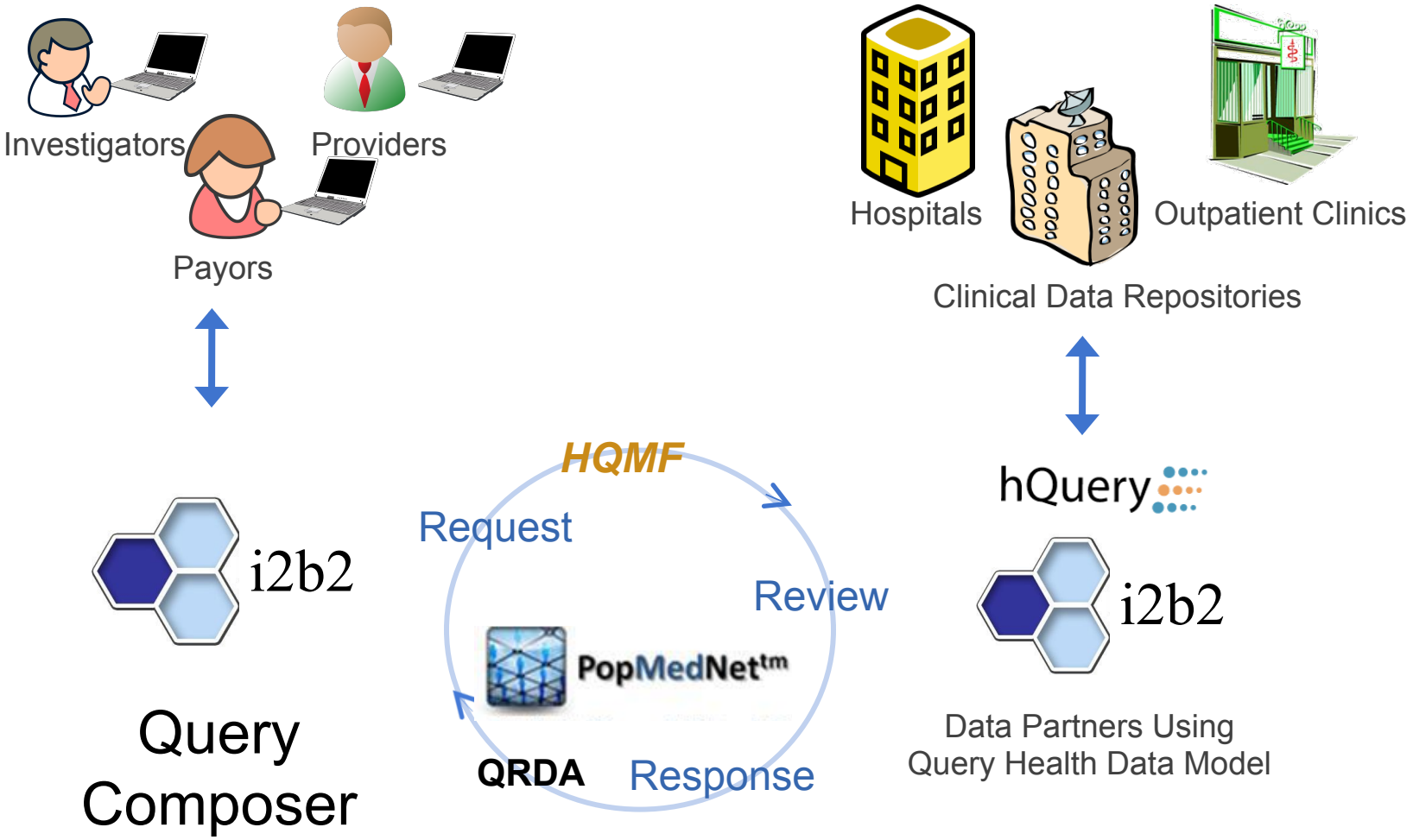
Query Health Reference Implementation



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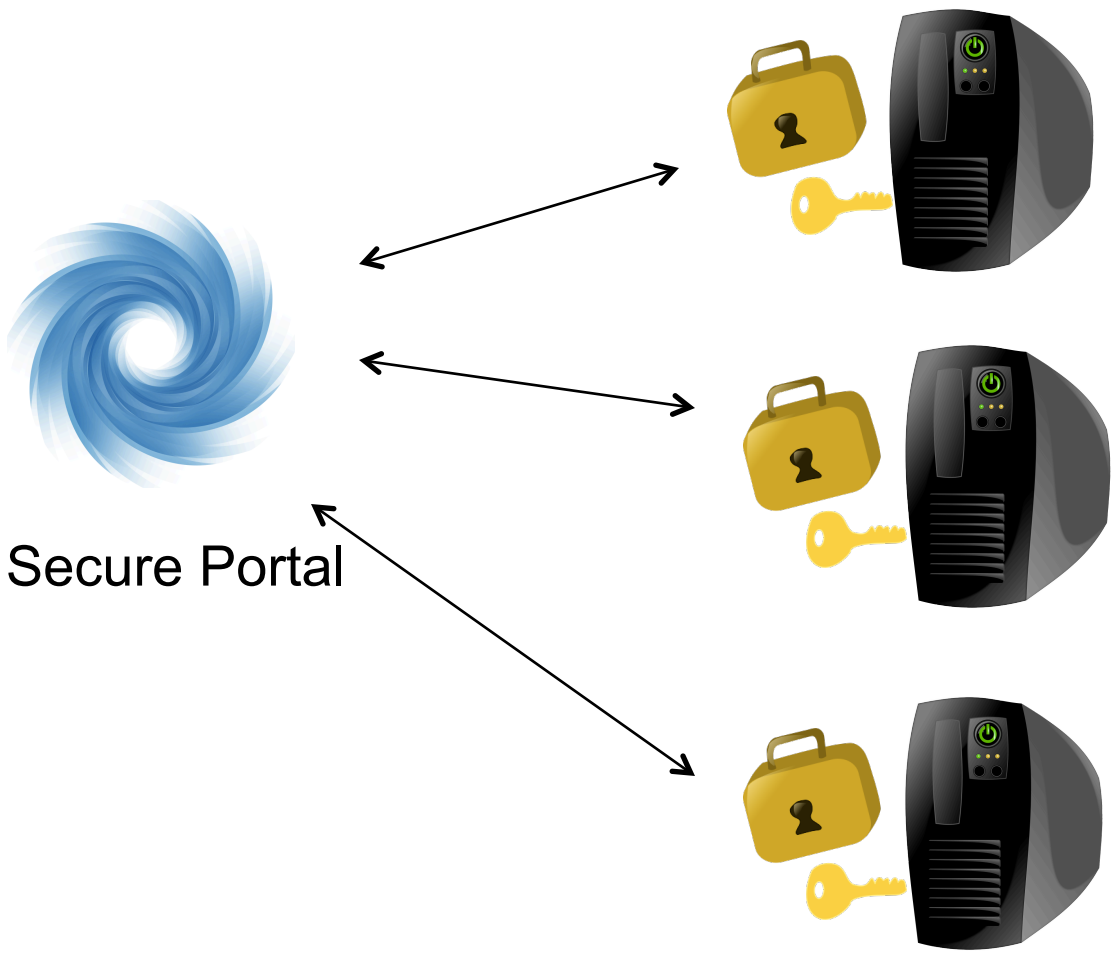

NIH Collaboratory
Health Care Systems Research Collaboratory

MDPHNET

Mini-Sentinel

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NYC Department of Public Health - Query Health Pilot Project – I2B2 / PopMedNet Distributed Query Tool

Home | Requests | Profile | Resources | Reports | Network

Network Browser <<

- Network
  - Organizations
    - HPHC-OPS
    - NYCDPH
    - RHIO
      - Users
        - jklannDMA
        - RHIODataMartAdministrator
        - RHIOAdministrator
        - mbuckDMA
        - dragonDMA
      - DataMarts
        - RHIO 1 - Auto I2B2 Data Source
        - RHIO 2 - Manual I2B2 Data Sou
        - RHIO 3 - I2B2 DataMart
        - RHIO 4 - I2B2 DataMart
        - RHIO 5 - I2B2 DataMart
      - Security Groups
  - Requests
    - Drafts
    - Recent
    - Submitted
    - Completed
  - Groups

Network ⇨ Organizations ⇨ RHIO ⇨ DataMarts ⇨ RHIO 3 - I2B2 DataMart

DataMart Info

Installed Models

Model	Last Metadata Request	Last Metadata
I2B2 Query Builder	N/A	N/A

Install... | Uninstall

Settings

Allow unattended operation

Modes

- Notify me of new requests, but do not process them automatically
- Process new request automatically but do not upload results
- Process new request automatically and upload results

Access Control

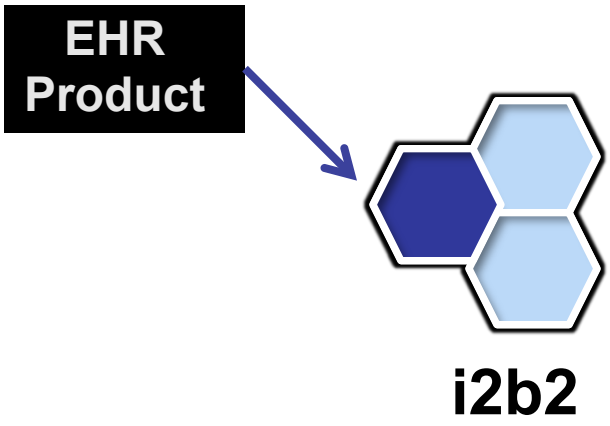
	Subject
[remove]	HPHC Operation Center\Administrators
[remove]	HPHC Operation Center\DataMartAdministrator
[remove]	NYC Dept Public Health\Investigators
[remove]	Regional Health Information Organization\Administrators
[remove]	Regional Health Information Organization\DataMartAdministrators
[remove]	Regional Health Information Organization\Everyone

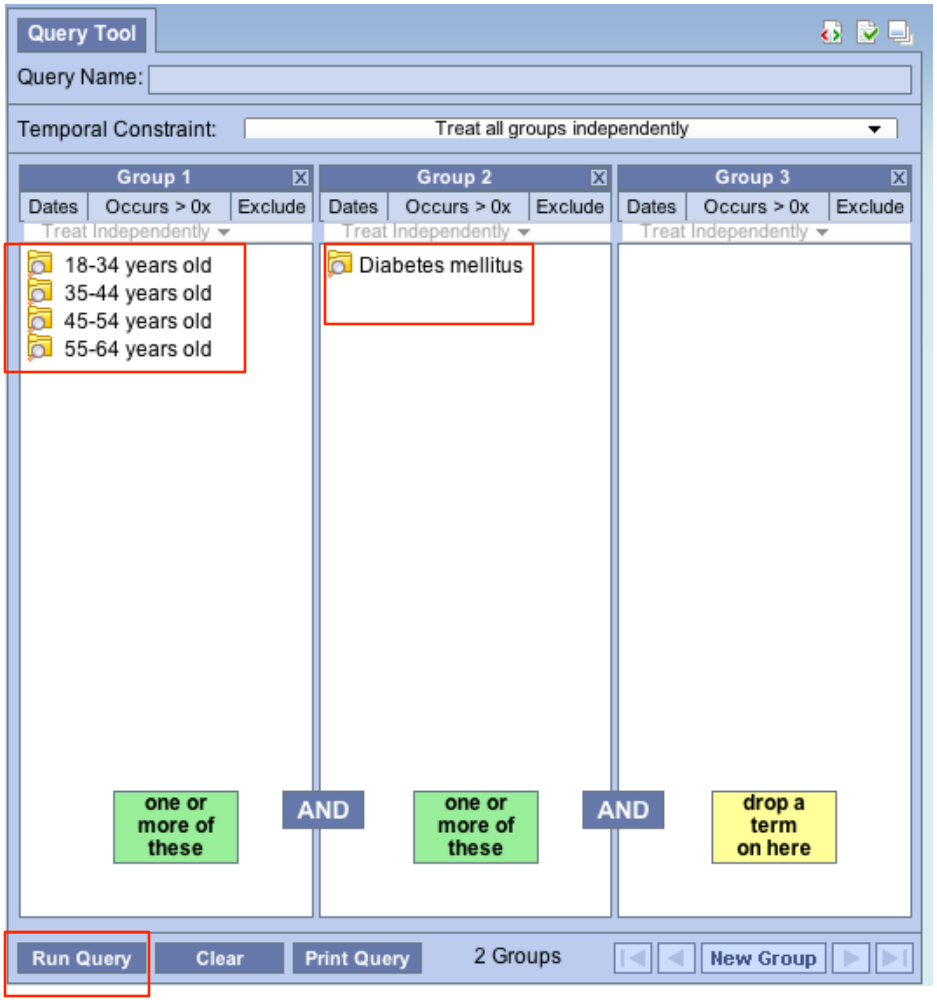
Add...

Right	Allow	Deny	
Manage Access	☑	☐	[inherited]
Edit	☑	☐	[inherited]
Delete	☑	☐	[inherited]
Read	☑	☐	[inherited]
Request Metadata Update	☑	☐	[inherited]
See Request Queue	☐	☐	
Upload Results	☐	☐	
Hold Requests	☐	☐	
Reject Requests	☐	☐	

i2b2

- Informatics for Integrating Biology and the Bedside





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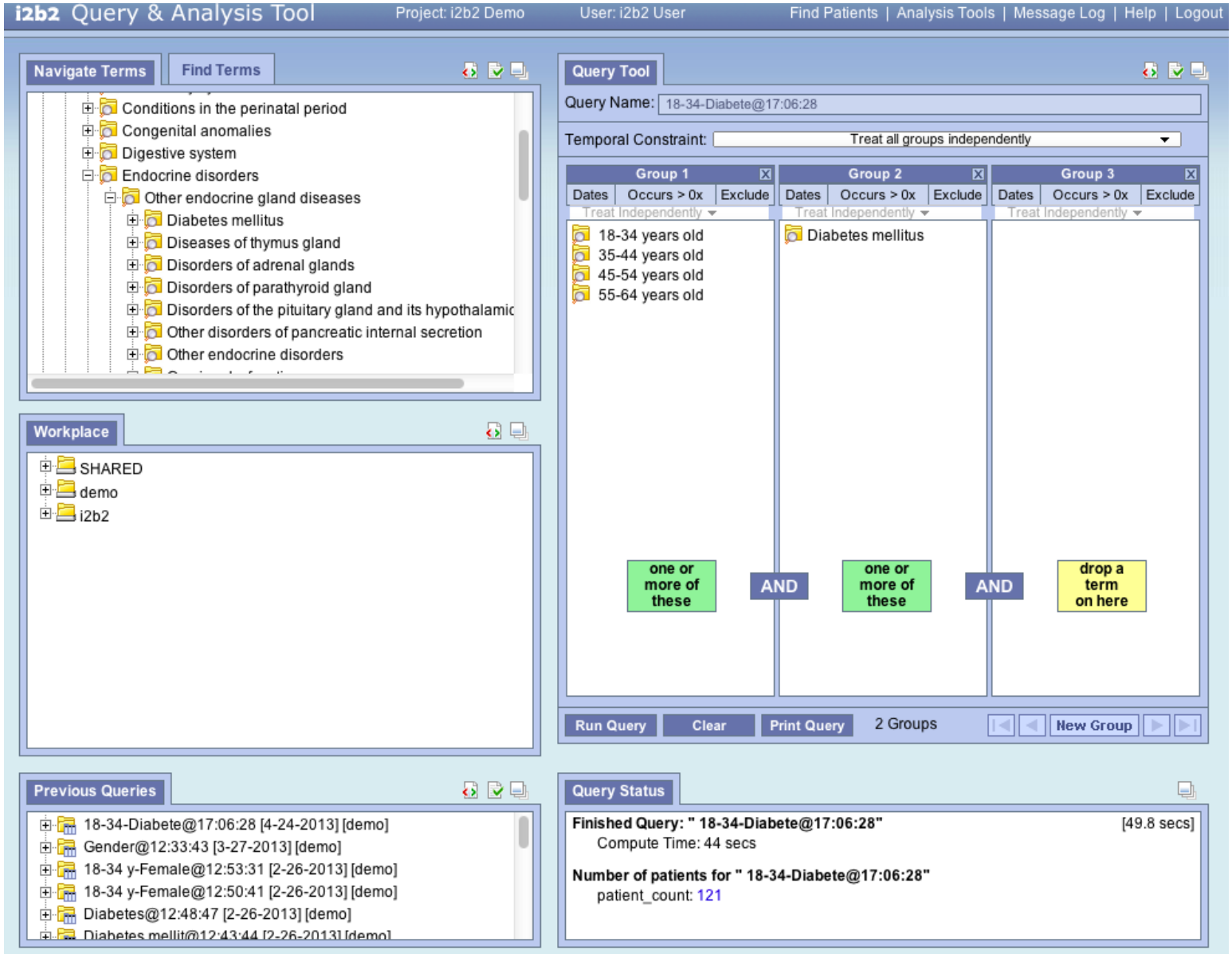
i2b2: Executing a Query



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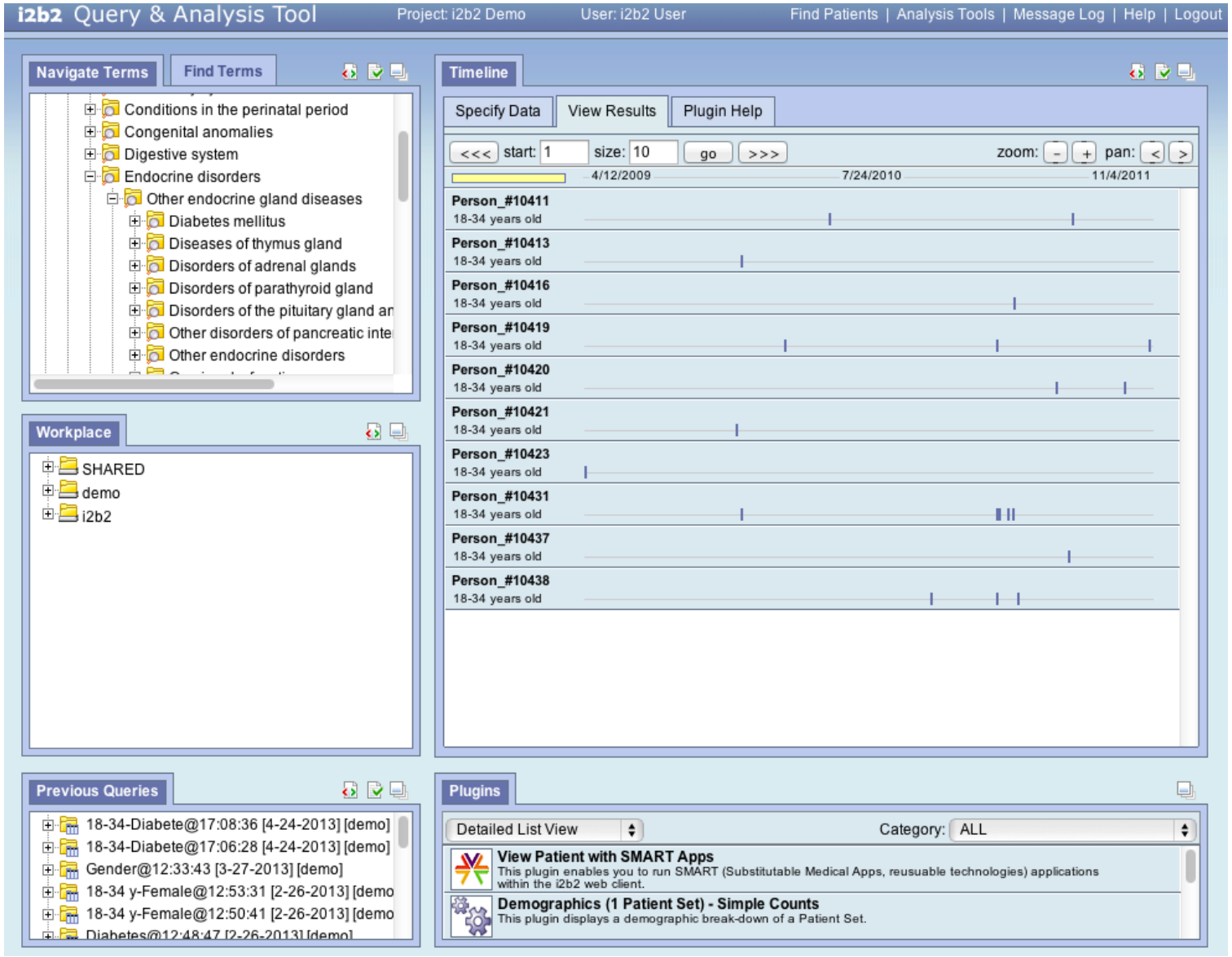
i2b2: The Timeline View



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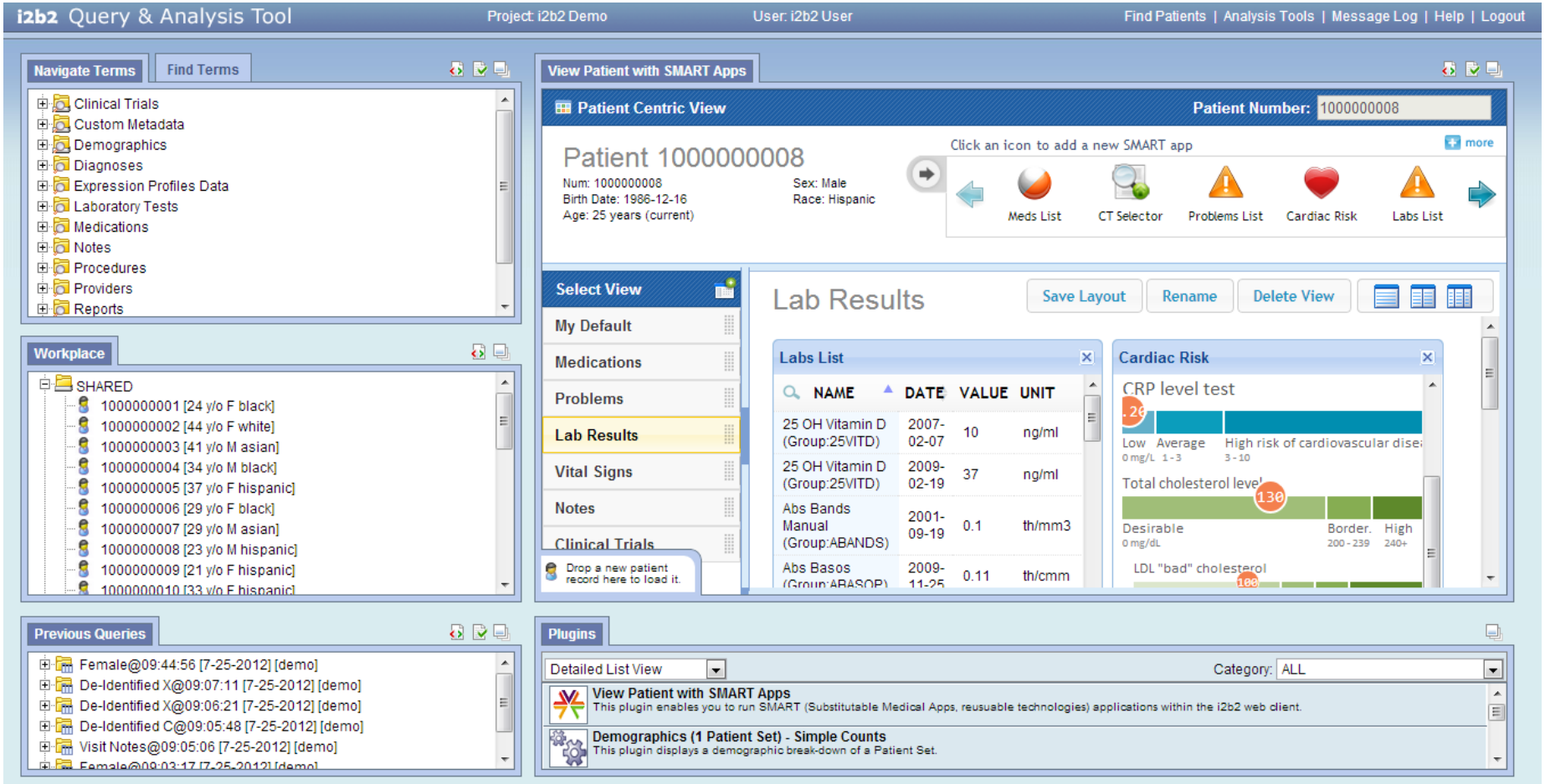
i2b2: The SMART view



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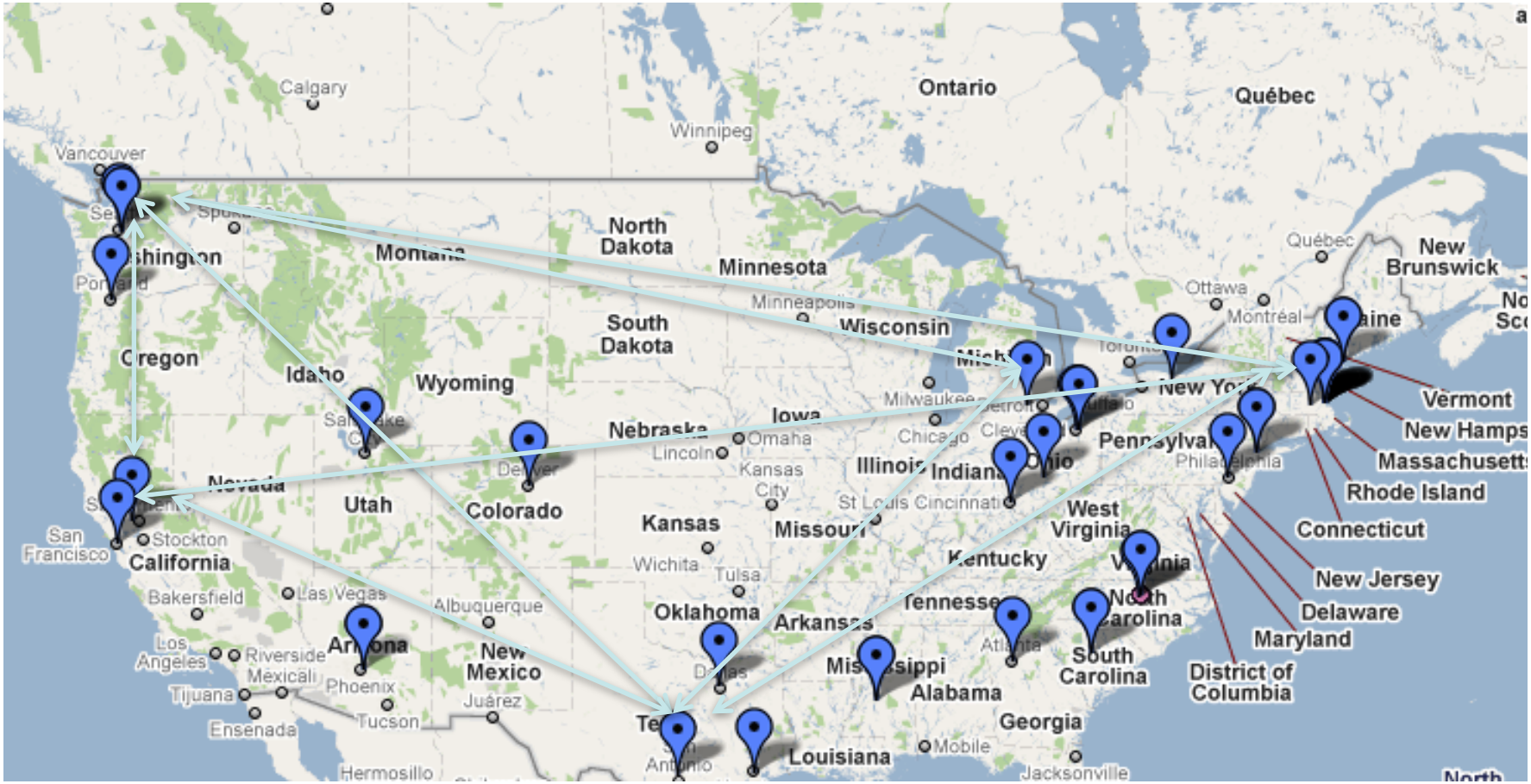
2012



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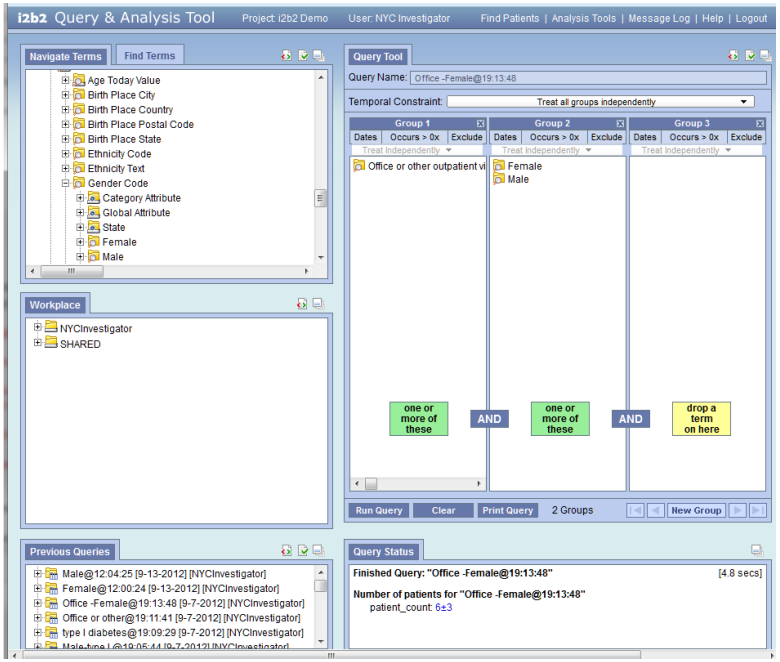
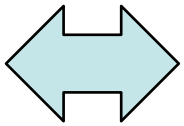
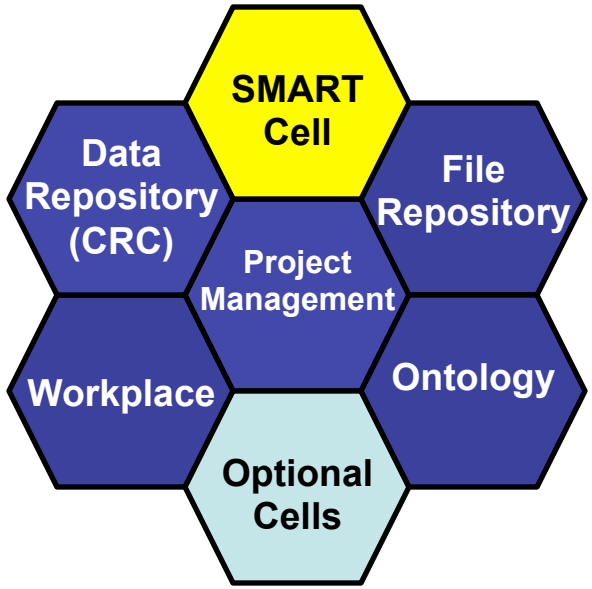
i2b2 for Query Health







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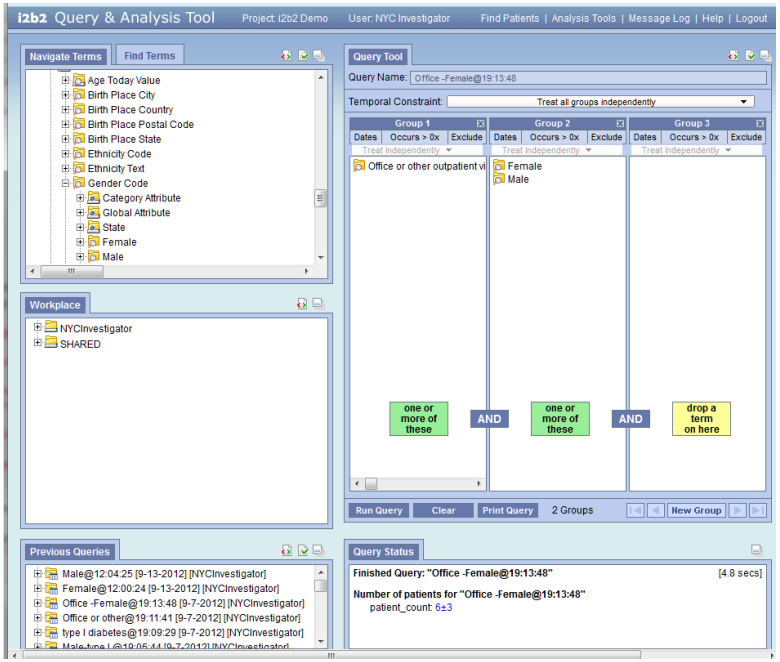
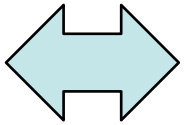
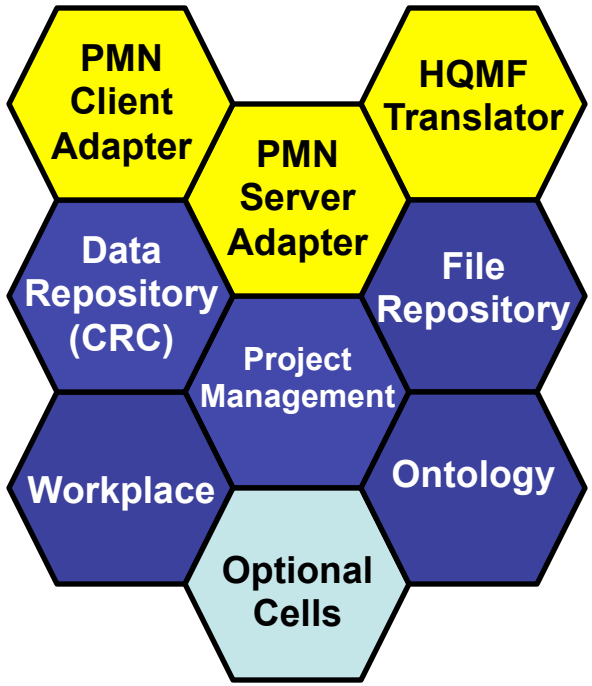
i2b2 for Query Health

- PopMedNet Adapters and HQMF Translator







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Workflow

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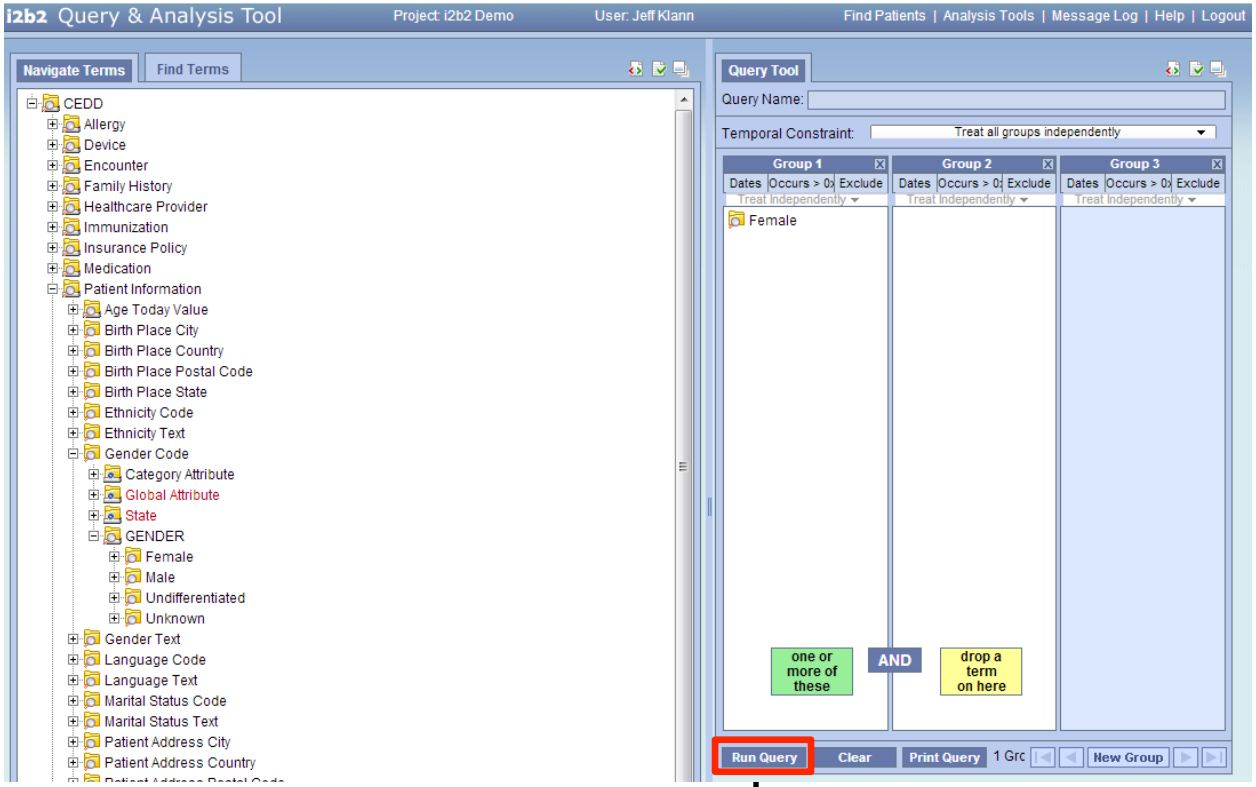
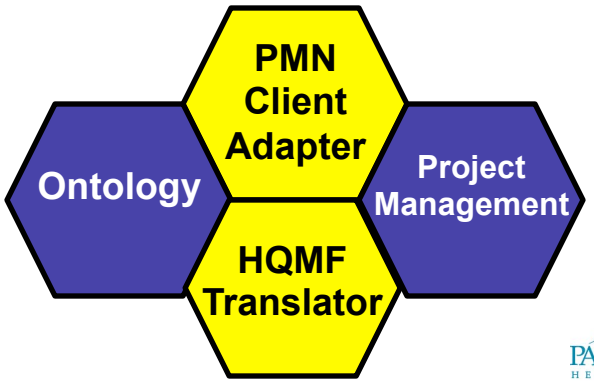
Step 1: Build Query (Investigator)





PopMedNet™

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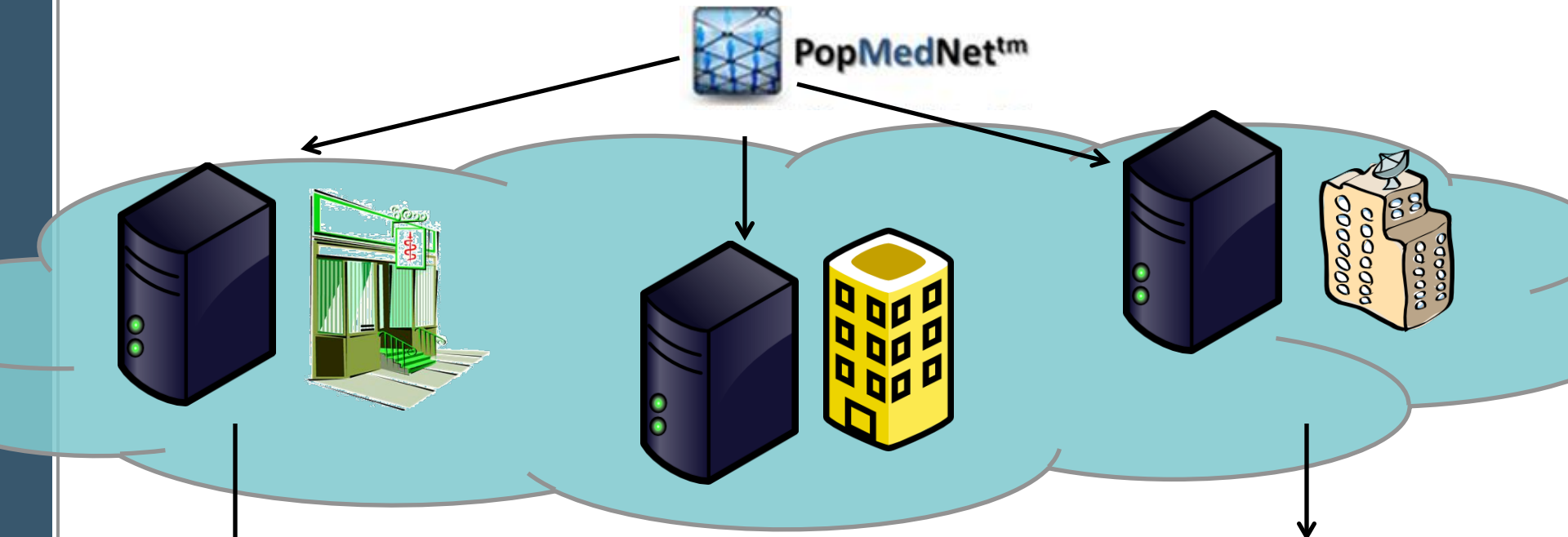
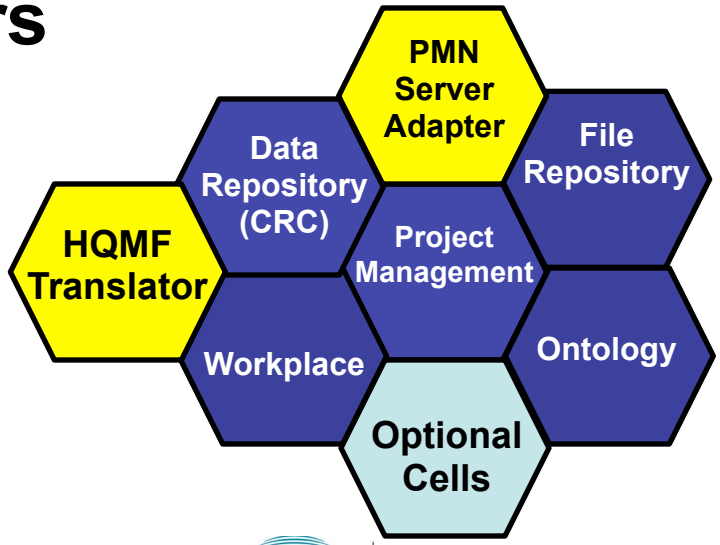
Step 2: Run Query (Data Partners)



i2b2



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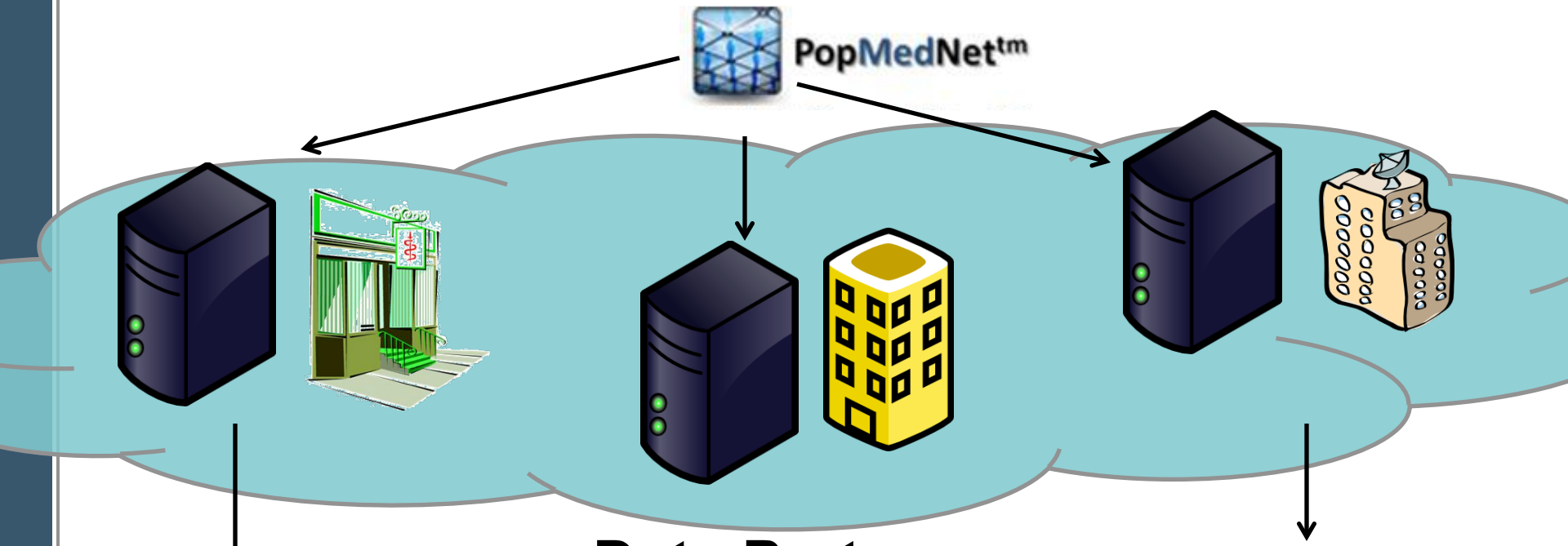

i2b2

hQuery

- CCD Document Database
- Developed HQMF query converter

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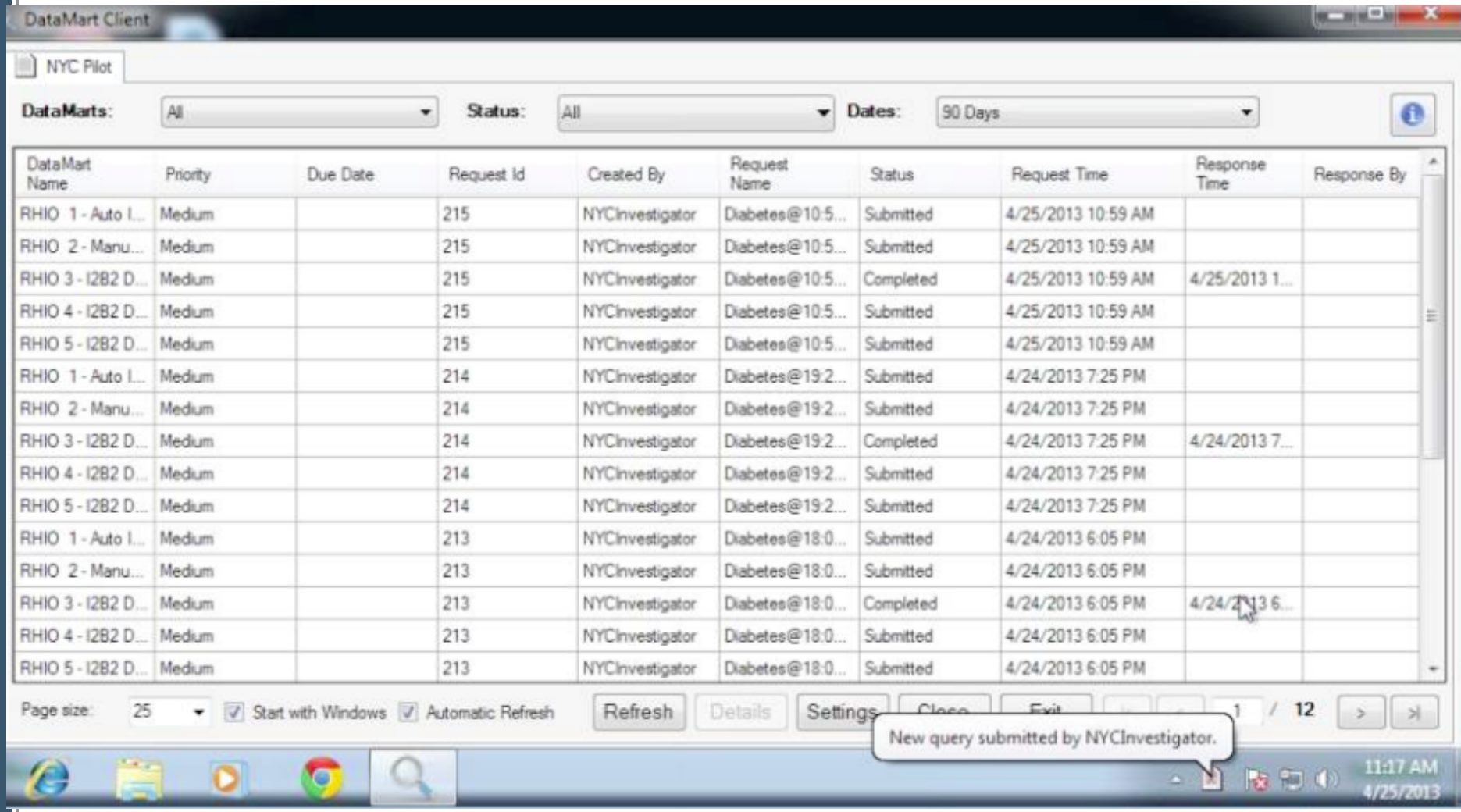

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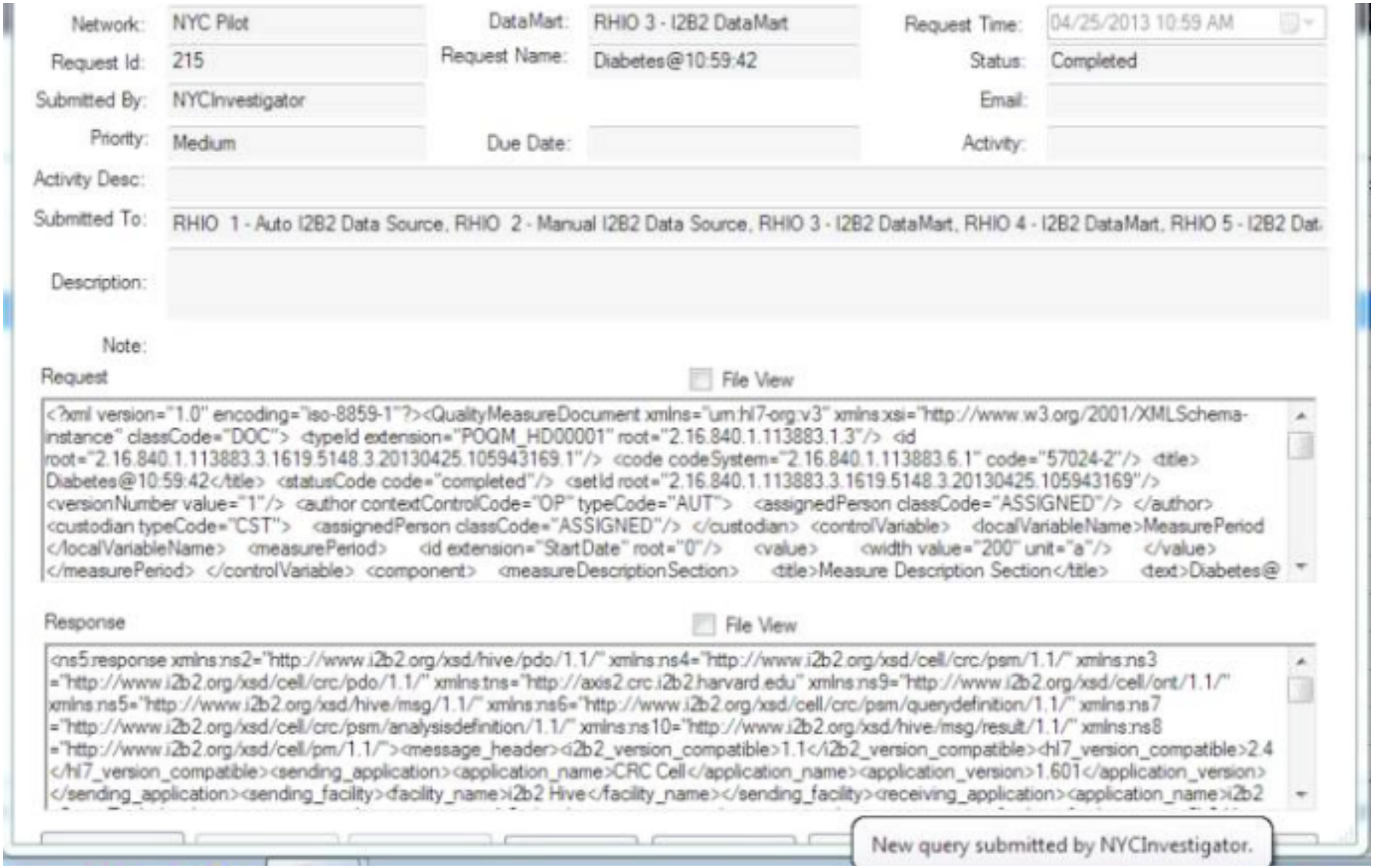

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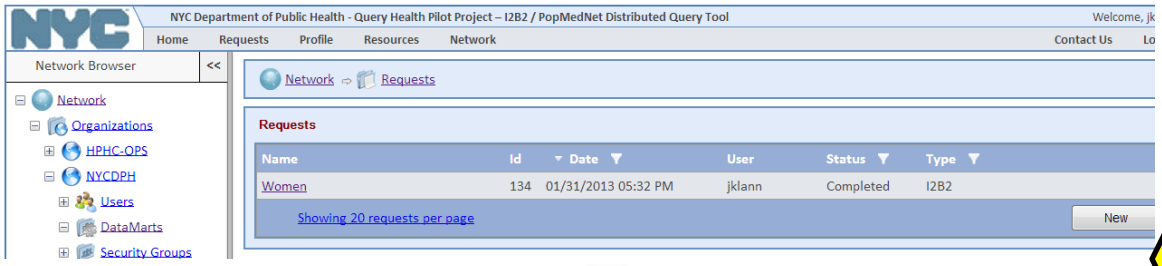
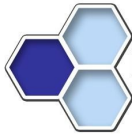
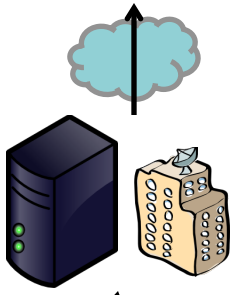
Step 3: Wait for Results



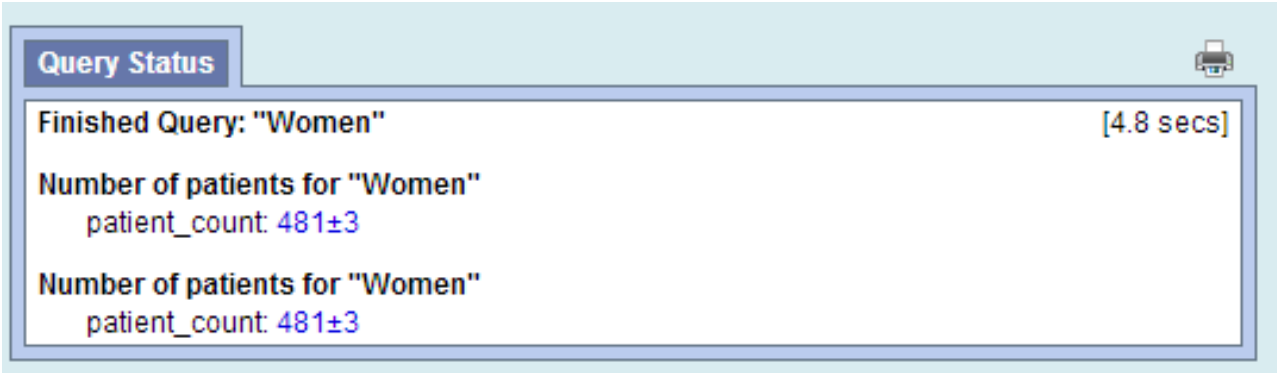


i2b2

PMN Client Adapter

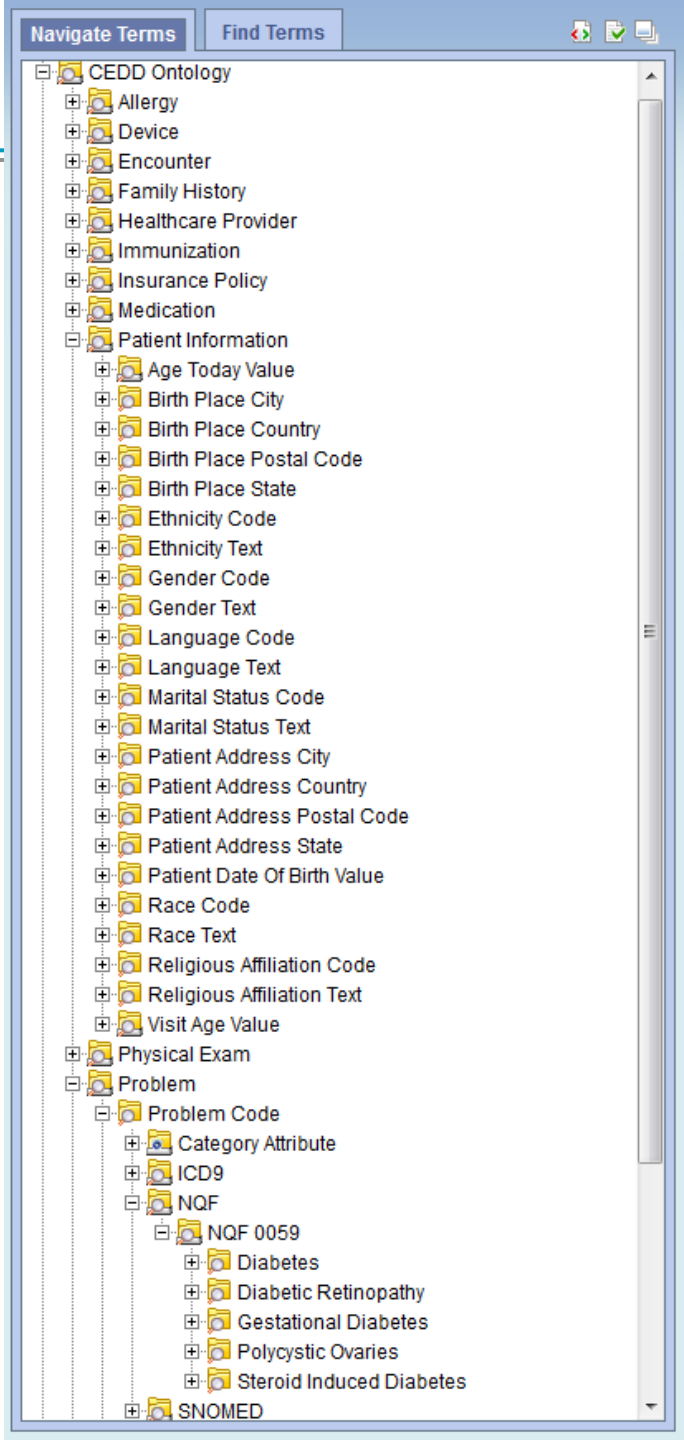


PMN Server Adapter

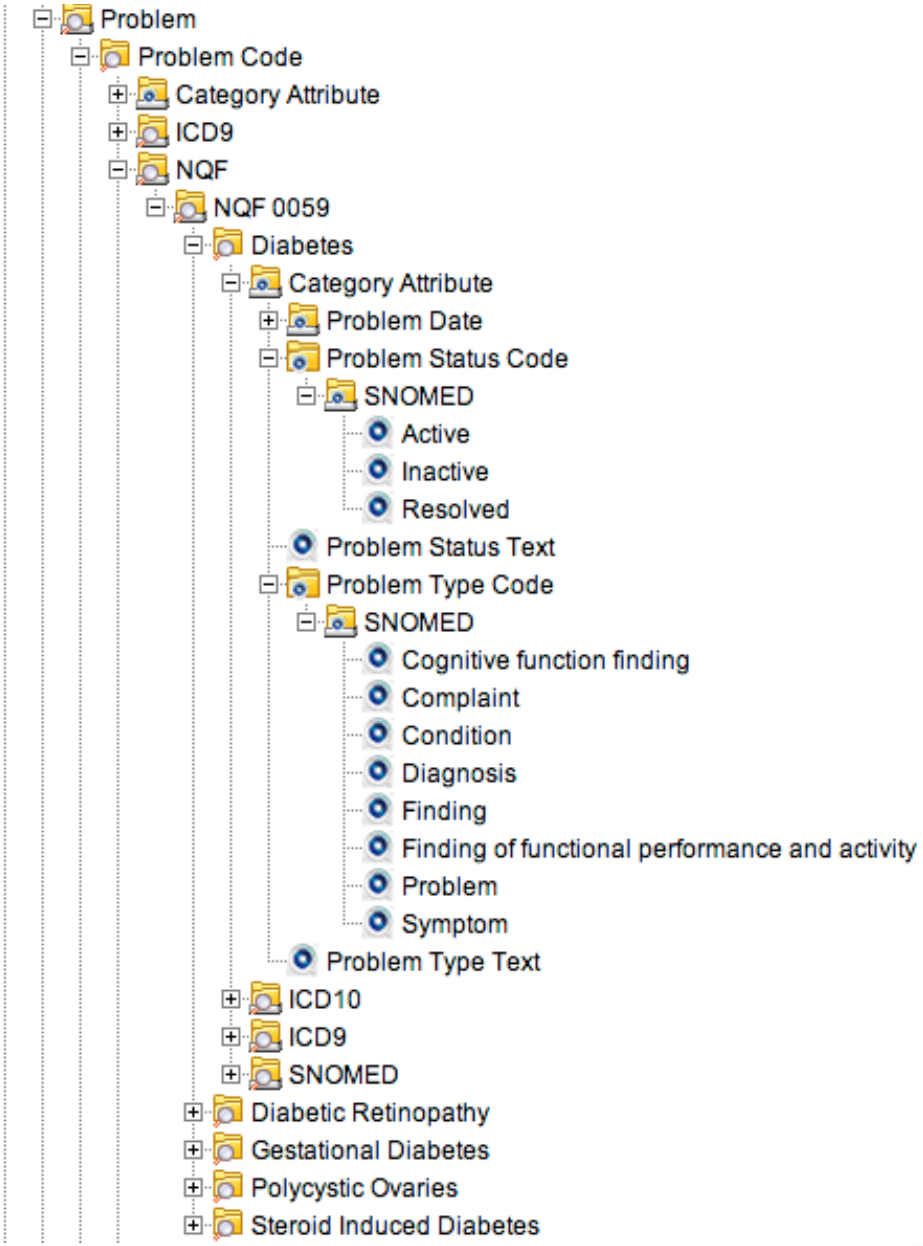


Query Health Ontology

- A QDM-based instantiation of CCDA
- Implemented as an i2b2 ontology



Query Health Ontology: Modifiers



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Results: Query Health Pilots

Massachusetts Department of Health

The New York City Department of Health and Mental Hygiene

FDA Mini-Sentinel

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Massachusetts Department of Health

Massachusetts eHealth Institute in collaboration with the Massachusetts Department of Public Health. MDPHnet is a population-based EHR surveillance network targeting a broad array of health indicators across multiple providers and delivery systems.

Goal: Implement Query Envelope security and authentication in existing public health surveillance network. *Feedback*: The Query Envelope enhancements provide standards-based approach for distribution of queries and return of results.	*Composer:* PopMedNet *Envelope:* PopMedNet *Processor:* EHR Support for Public Health (ESP)

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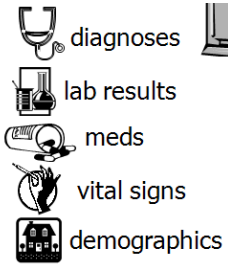
MDPHNET

Electronic Support for Public Health (ESP)

Query

Response

Health Department



Practice EMRs

Massachusetts League of Community Health Centers

Atrius Health

Cambridge Health Alliance

***JAMIA* 2009;16:18-24**
***Am J Pub Health* 2012;102:S325–S332**

New York City Department of Health

The New York City Department of Health and Mental Hygiene currently has a network of over 650 primary care practices that respond to distributed queries. This enables their teams of quality improvement specialists to provide regular feedback to the practices in order to respond to public health concerns for both chronic and acute conditions. The Department is adopting the Query Health platform to add additional practices and health information exchange organizations.

Initial goal: Demonstrate standards-based vendor-neutral distributed analytics solution using Query Health Standards.

Current goal: Launch health information exchange-based solution to obtain aggregate city-wide healthcare statistics

Feedback: Standards-based aggregate distributed analytic solutions are now capable of delivering valuable results. Challenges remain in cross-site data harmonization.

Composer: i2b2

Envelope: PopMedNet

Processor: i2b2

Other: HQMF, Ontology

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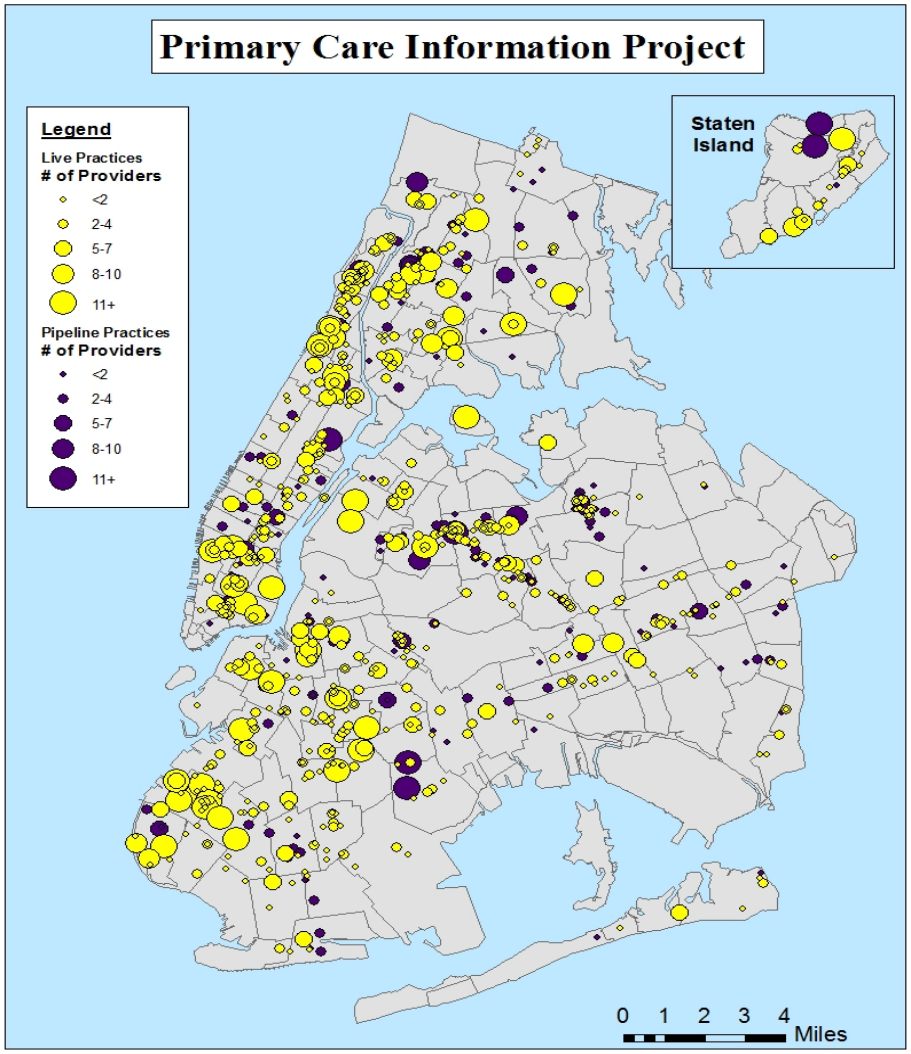
The Hub Population Health Network



"The Hub" allows secure exchange of aggregate data with PCIP practices on the eClinicalWorks EHR

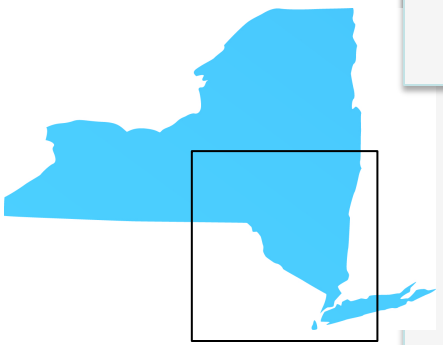
- Send out queries
- Receive patient counts overnight

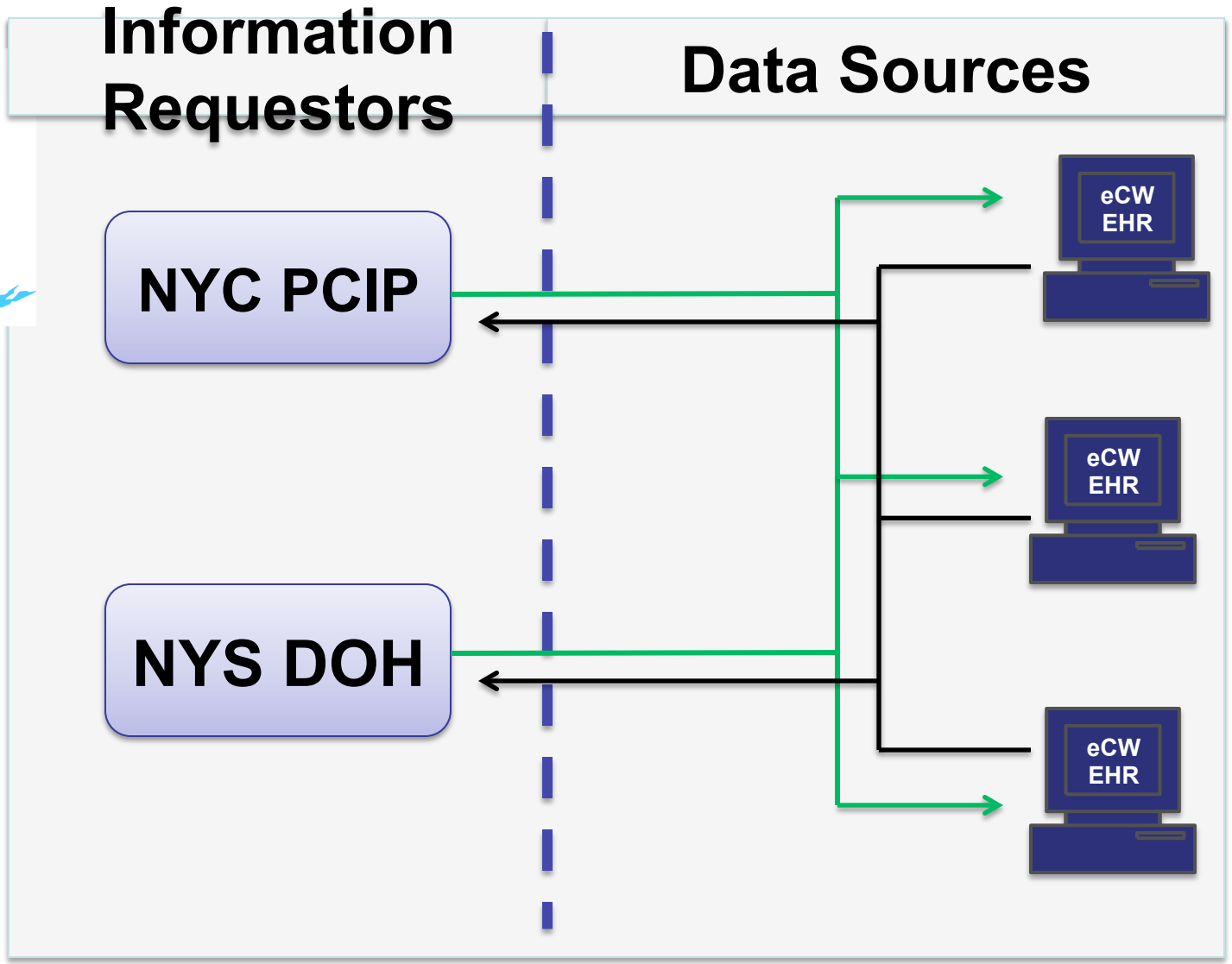
The Hub currently covers:

- 700+ practices
- ~1.8 M patients per year
- 5 M+ patients since 2009

Buck MD, Anane S, Taverna J, Amirfar S, Stubbs-Dame R, Singer J. The Hub Population Health System: Distributed Ad Hoc Queries and Alerts. J Am Med Inform Assoc. Published Online First: 9 November 2011. doi:10.1136/amiajnl-2011-000322.

New York City Department of Health





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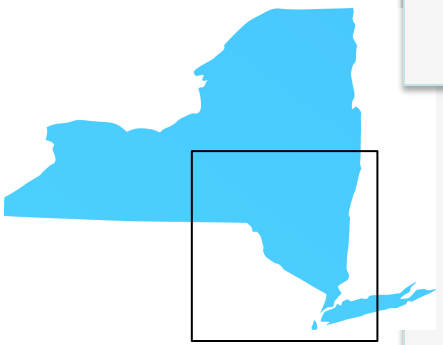
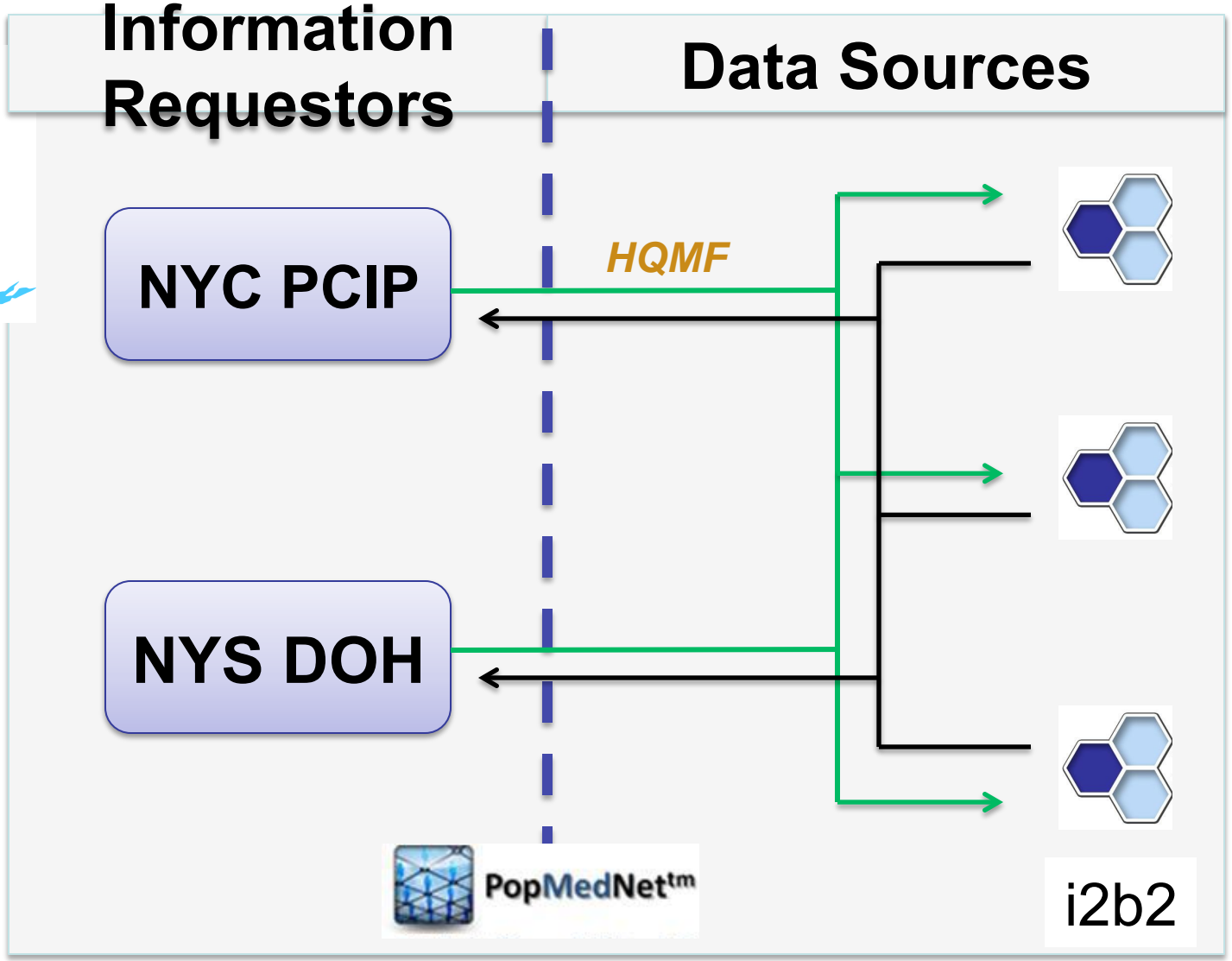
New York City Department of Health





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FDA Mini-Sentinel

The FDA's Mini-Sentinel project aims to monitor medical product safety using electronic health data. Mini-Sentinel is using Query Health standards implemented through PopMedNet for distributed querying and receiving results within a network of over 130 million individuals. The Query Health pilot investigates adding i2b2 clinical data repositories to the Mini-Sentinel network to expand the medical product safety monitoring capabilities of the network.

Goal: Expand medical product safety surveillance capabilities to i2b2 clinical data sources. *Feedback:* Clinical data sources can provide important additional data for medical product safety surveillance. Resources required for data normalization and maintaining additional software at data partners must be carefully considered.	*Composer:* i2b2 *Envelope:* PopMedNet *Processor:* i2b2 *Other:* HQMF

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Query Health Reference Implementation

https://community.i2b2.org/wiki/display/queryhealth/Home

- HQMF<-> i2b2 Translator
- i2b2 Query Health Ontology
- PopMedNet v3 and adapter cells

http://www.popmednet.org

https://www.i2b2.org/software

https://github.com/hquery

https://code.google.com/p/query-health/downloads

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Outline

- Introduction
  - Background
  - Objective
- Materials and Methods
- Results
  - Implementation
  - Pilots
- **Discussion**
  - **Future Directions**

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Discussion

- Query Health is a powerful test of the nation's progress toward an LHS.
- Query Health has:
  - Created a vendor-neutral, standards-based approach for distributed population health queries
  - Delivered an open-source reference implementation with several alternative configurations;
  - Co-developed a new revision of HQMF
  - Validated our system for three very different use cases.
- Challenges
  - Data access and interoperability
  - Maturation of standards (HQMF, QRDA, C-CDA)

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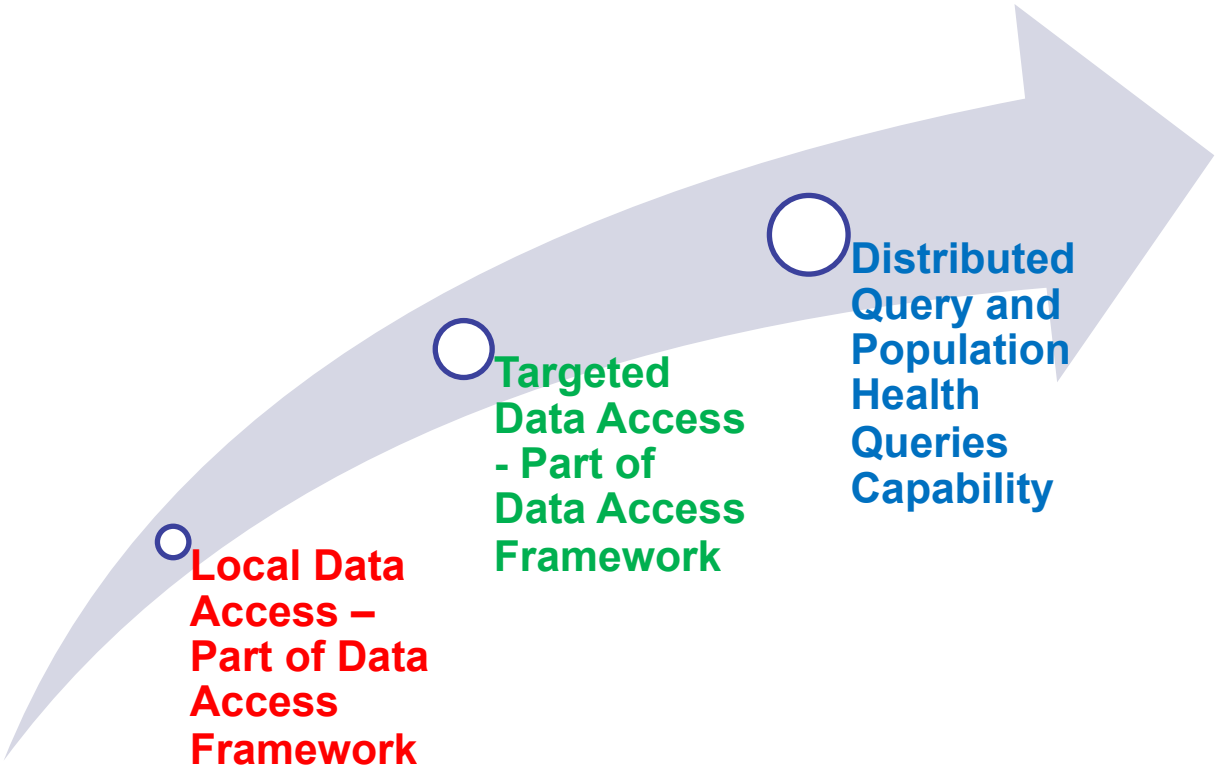
Data Access Framework



Lessons Learned from Pilots and other activities indicate that implementing distributed queries across the nation will require multiple incremental steps each of which develop the capabilities required for distributed queries and Learning Health System in the long run.

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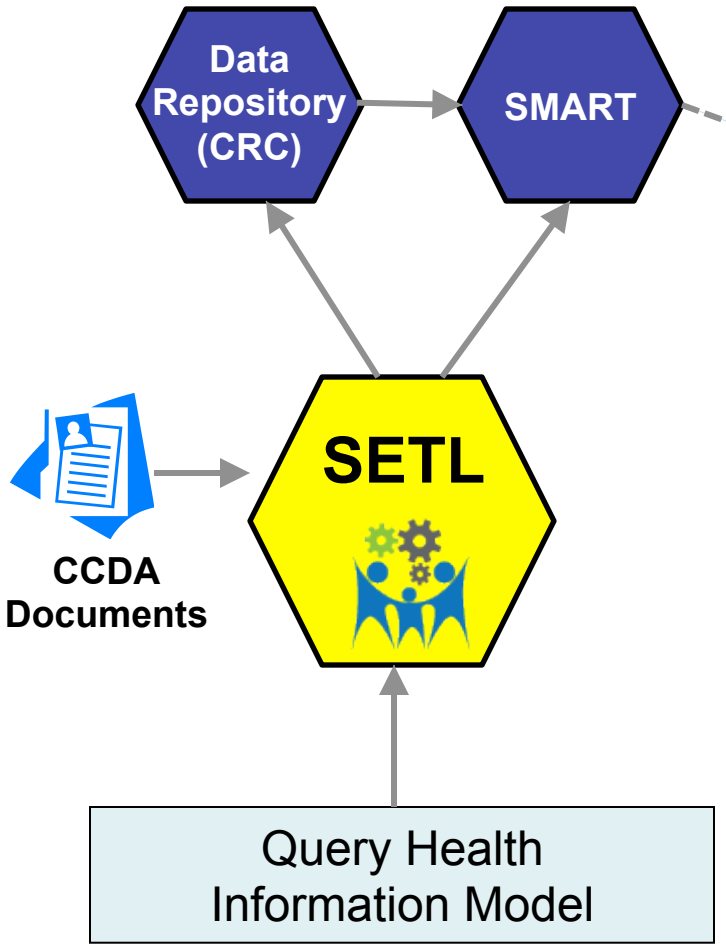
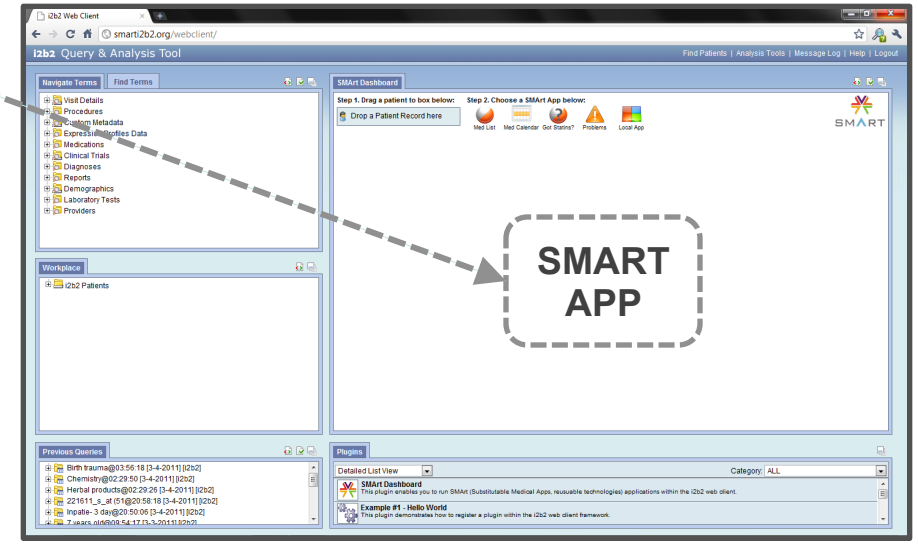
CCD Import for i2b2





Klann J, Porter A, Wattanasin N, Murphy S. Importing Continuity of Care Documents into i2b2 and SMART. In: *AMIA Joint Summits*. 2014. 143.

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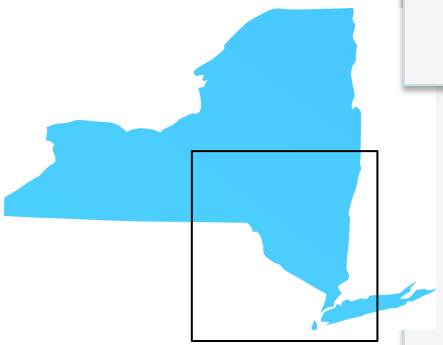
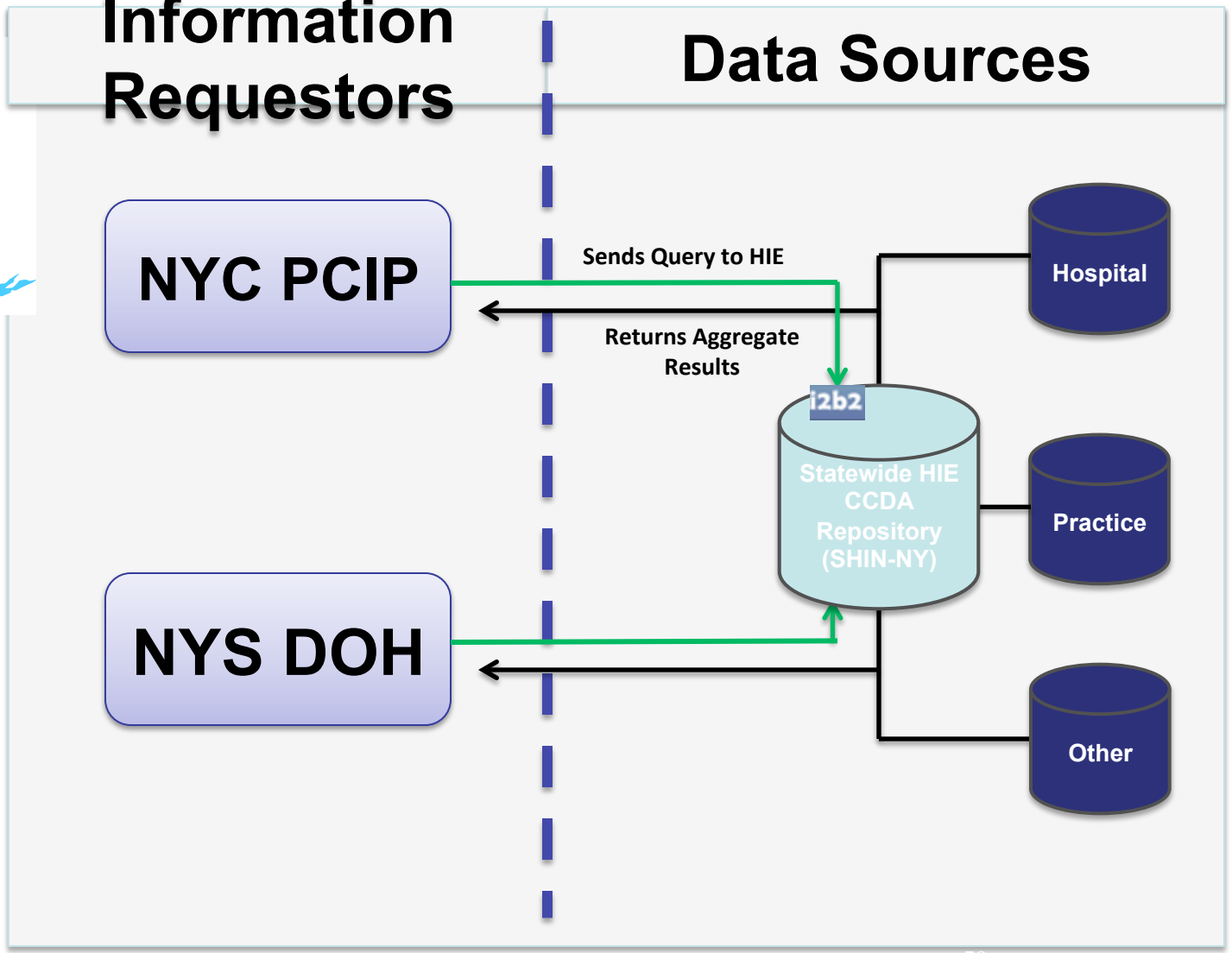
New York Population Health Registry

Stage 2 Meaningful Use Proposal





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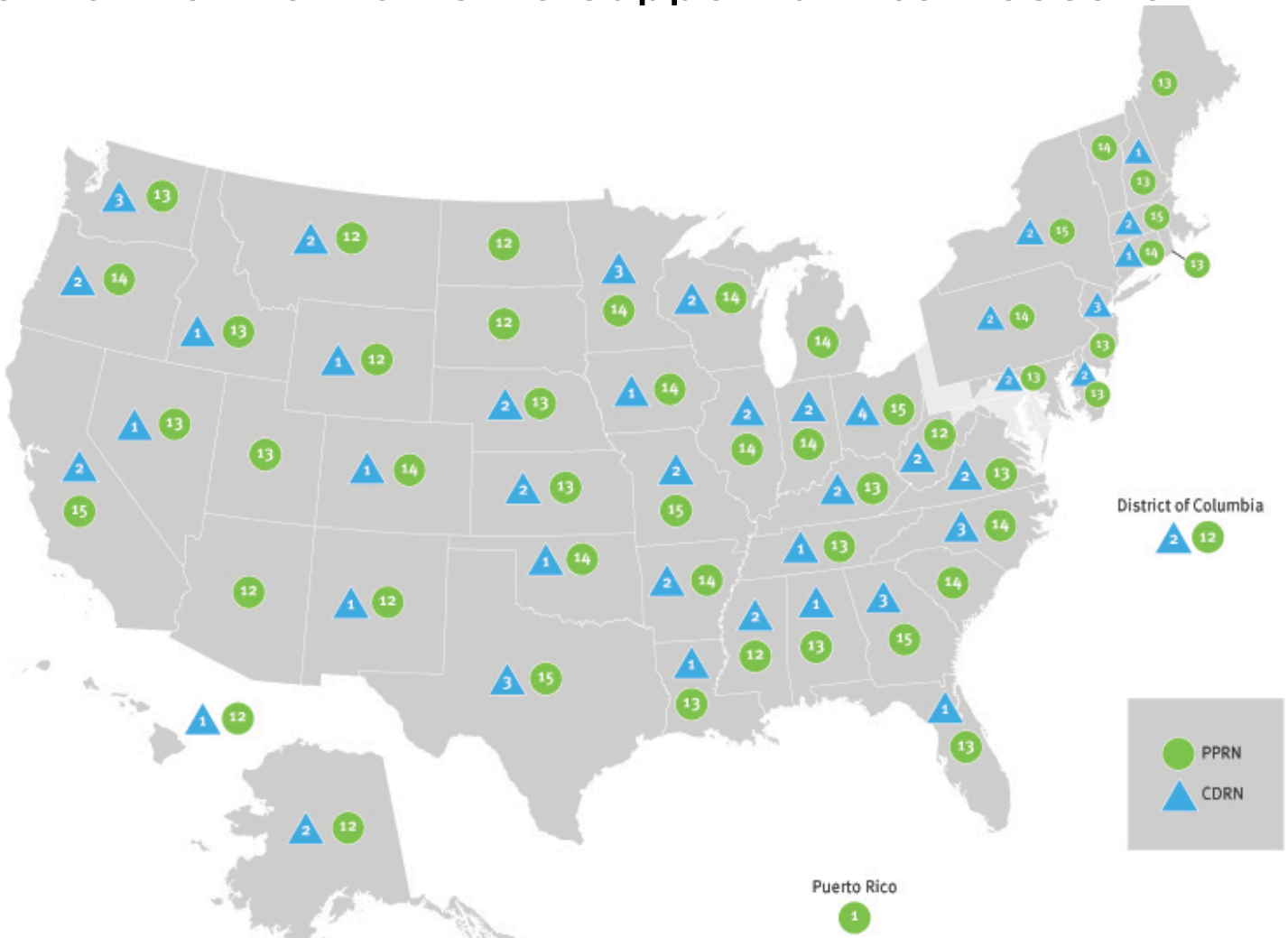
pcornet

- A “network-of-networks” to support clinical research.



http://pcornet.org/wp-content/uploads/2014/04/20140420-PCORnet15mintalk.pptx

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pcornet

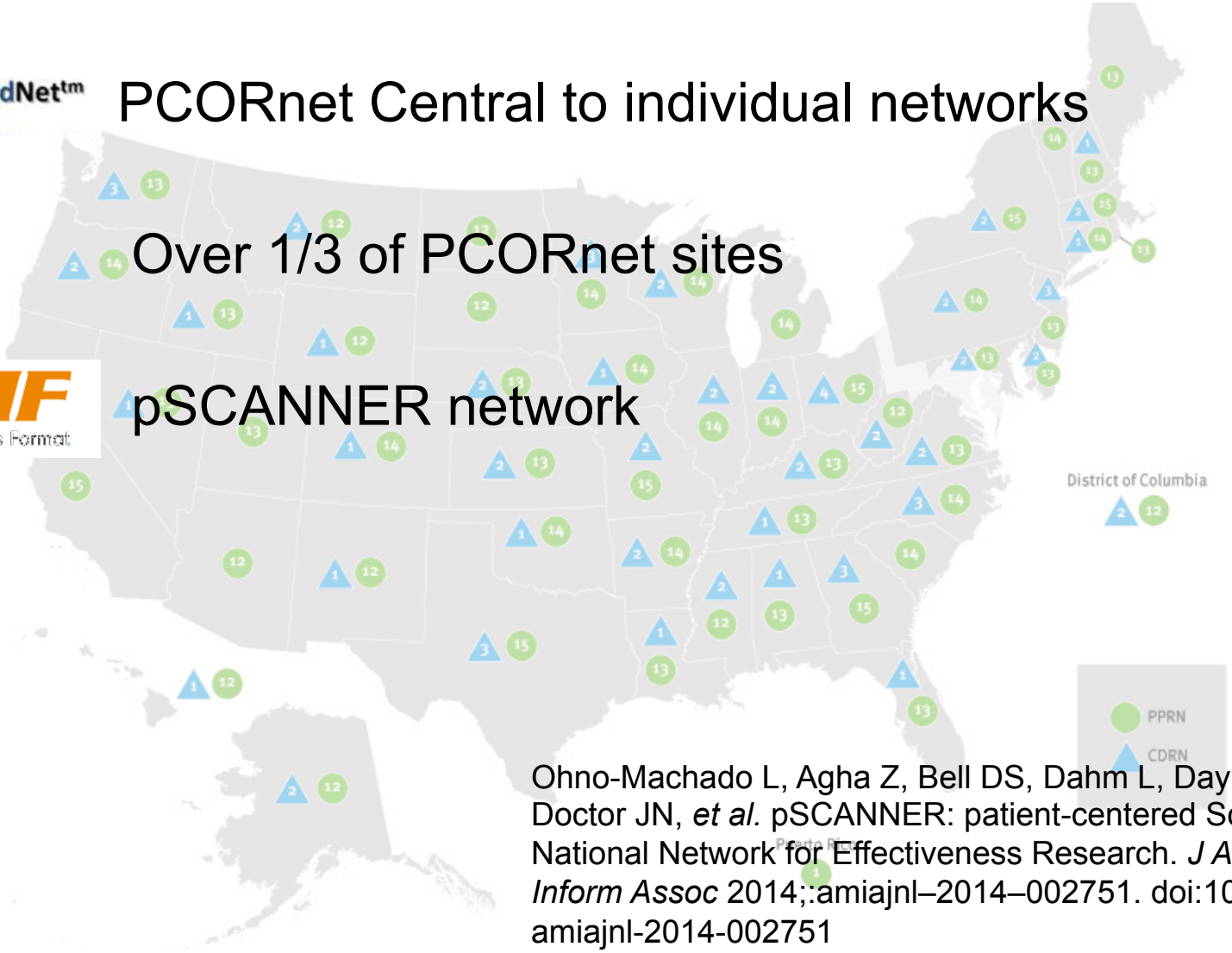
PopMedNet™

PCORnet Central to individual networks

Over 1/3 of PCORnet sites

HQMF
Health Quality Measures Format

pSCANNER network



Ohno-Machado L, Agha Z, Bell DS, Dahm L, Day ME, Doctor JN, *et al.* pSCANNER: patient-centered Scalable National Network for Effectiveness Research. *J Am Med Inform Assoc* 2014;:amiajnl–2014–002751. doi:10.1136/amiajnl-2014-002751

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Other Initiatives

- ONC Clinical Quality Framework
  - Harmonize HQMF and HeD
- Analysis of CQMs on clinical data
  - Hadley,M, McCready, R, Delano,D, Devarajan, S. Assessing the Feasibility of Meaningful Use Stage 2 Clinical Quality Measure Data Elements at the Massachusetts eHealth Collaborative. RAND Report, 2013 Sep.
- NIH Research Collaboratory
  - New distributed networks involving PopMedNet and i2b2
- New SHRINE networks
- Learning Health Community
  - http://healthinformatics.umich.edu/lhs

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- ONC
  - Doug Fridsma, Chief Science Officer and Director of Science and Technology
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- Bruce Swan (PopMedNet)
- Keely Benson (Massachusetts eHealth Institute)
- Bill Simons (i2b2 SHRINE)

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Questions?

- Jeff Klann, PhD
  - Jeff.Klann@mgh.harvard.edu

- i2b2 wiki:

  https://community.i2b2.org/wiki/display/queryhealth/Home

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