# Partners in Interoperability: Clinician's Challenge

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Johns Hopkins University, Baltimore

Stanley M. Huff, MD

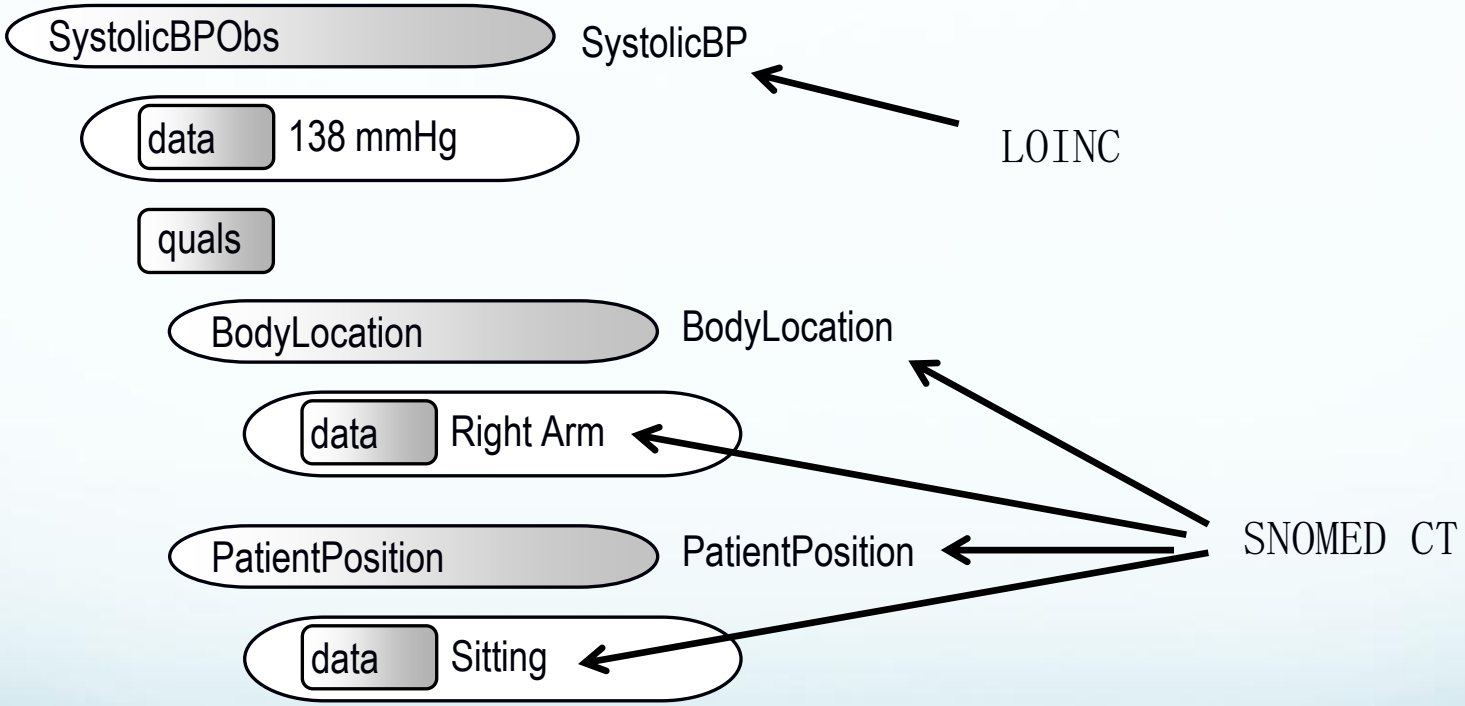
# My Goals for this Meeting

- Agree to a simple, doable project that we can work on together that has value for clinicians
  - Figure out how to fund a project
- Propose a process for industry wide approval of a set of models to support true interoperability (a stepwise process)

# Outline

- Current situation and a vision for the future
- What is plug-n-play interoperability?
- The path to interoperability

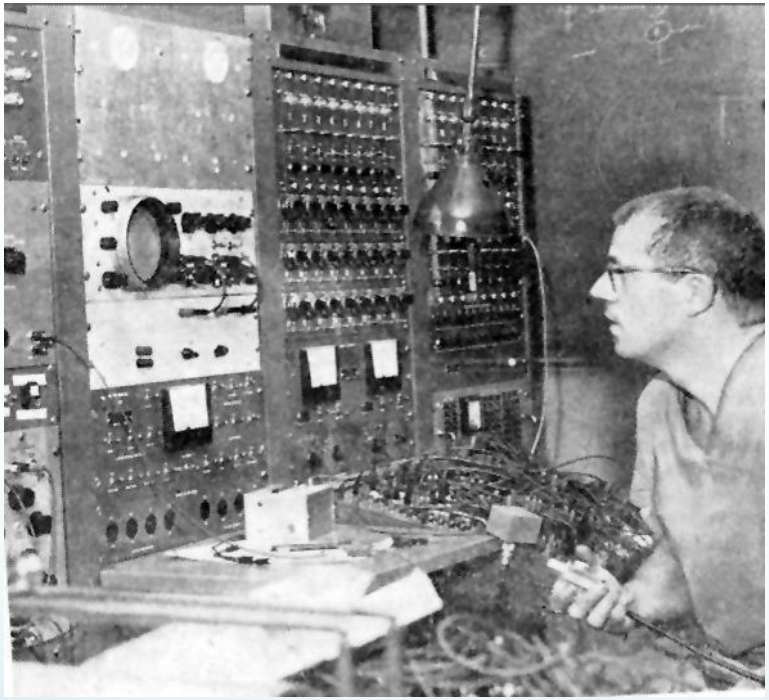
# Graphic of a Detailed Clinical Model



# Why?

"To help people live the healthiest lives possible."

# Homer Warner and HELP



Intermountain can only provide the highest quality, lowest cost health care with the use of advanced clinical decision support systems integrated into frontline clinical workflow

**Dr. Homer Warner**

# Decision Support Modules

- Antibiotic Assistant
- Ventilator weaning
- ARDS protocols
- Nosocomial infection monitoring
- MRSA monitoring and control
- Prevention of Deep Venous Thrombosis
- Infectious disease reporting to public health
- Diabetic care
- Pre-op antibiotics
- ICU glucose protocols
- Ventilator disconnect
- Infusion pump errors
- Lab alerts
- Blood ordering
- Order sets
- Patient worksheets
- Post MI discharge meds

# We can't keep up!

- We have ~150 decision support rules or modules
- We have picked the low hanging fruit
- There is a need to have 5,000+ decision support rules or modules
- There is no path from 150 to get to 5,000 unless we fundamentally change the ecosystem

# Current Situation

- Each EHR vendor uses a proprietary database schema, proprietary models and unique terminology to represent clinical data
  - Some standardization of codes is now occurring, but
  - Data is not consistent vendor to vendor, or even organization to organization within the same vendor
- This means that:
  - Sharing data is difficult
  - Sharing executable software across vendors is impossible
  - Each useful application is created or re-created on each different platform
  - There are unmet needs for health care applications and decision support
  - Software costs are higher than they need to be

# The Future Ecosystem

- Standards are defined that enable "truly" interoperable systems using standards based services
- Old and new EHR vendors:
  - Support standards based services (HL7 FHIR®)
  - Support SMART® applications
- Thousands of people develop software that runs on truly interoperable platforms
  - Open source, academics, and for profit developers
  - Apps, including clinical decision support algorithms, are for sale in a vendor neutral app store
  - Apps can be certified as HSPC compliant
  - Platform vendors certify apps as safe for use in their platform

# The Future Ecosystem (2)

- People buy a patient data platform
  - Includes auditing, security, authorization, patient selection, etc.
  - May include some core apps: order entry, results review, notification, etc.
- People buy the apps they need
- There is also a marketplace for sharing knowledge, especially protocols, workflows, order sets, ontologies
- Patients receive better care at a lower cost because lower cost higher quality apps are available as driven by market forces

# SMART on FHIR®© – Open Platform Architecture

SOA Orchestration

mHealth

OAuth

FHIR® REST API

FHIR Profiles from CIMI Models

SMART™ Web Apps

Children's Hospital Boston

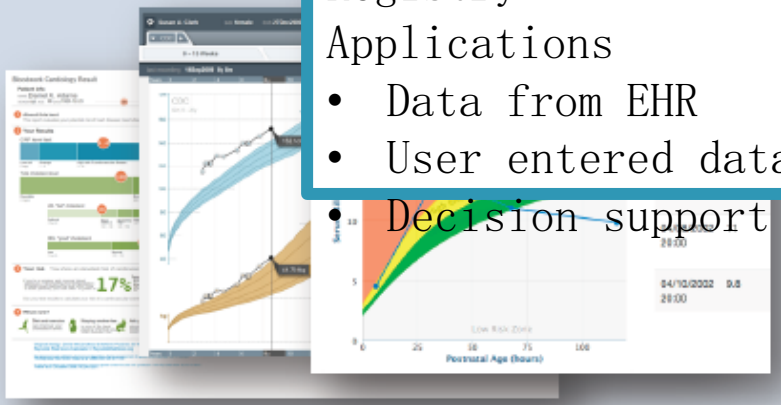
Intermountain Healthcare

visualdx

"polyglot" Health Through Understanding

Trusted App Registry

HARVARD MEDICAL SCHOOL



Registry Applications

- Data from EHR
- User entered data
- Decision support

http://smartplatforms.org/smart-on-fhir/

Heterogeneous Systems

**Exhibiting Health IT Systems**

Cerner

Booth# 6965

Intermountain Healthcare

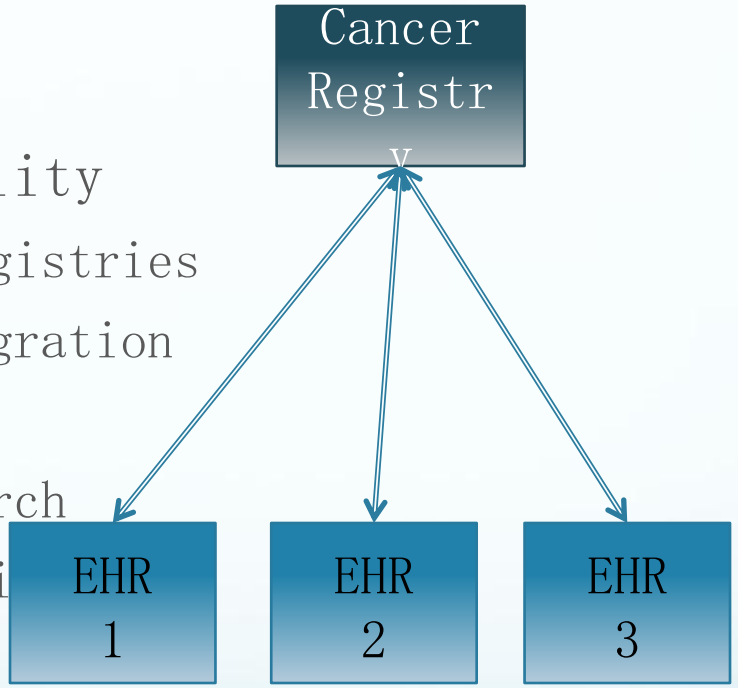
Booth# 3903

MQIP

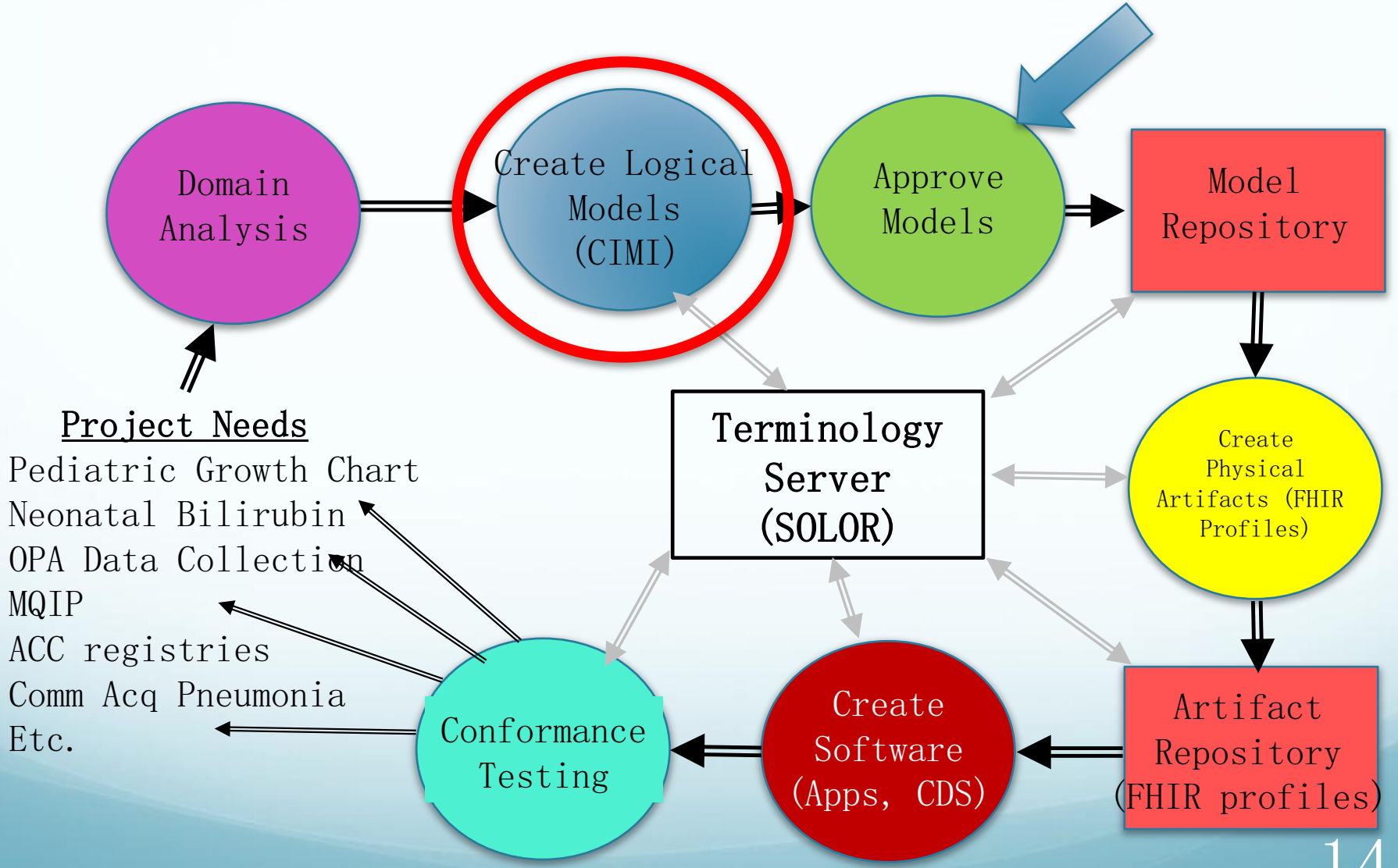
Others…

# Apps that enable data sharing…

- Next-gen Interoperability
  - Disease and quality registries
  - Population Health integration
  - HIE integration
  - Data capture for research
  - Clinical Trial recruiti



# The Interoperable App Development Process



# Model Repository and Model Adoption

Model Repository

| Model Id | Status | Version | Isosemantic Family | Model content | Meta data |
|---|---|---|---|---|---|
| Hematocrit | DSTU | 2 | 2123 | XXXX | YYY |
| Blood Pressure | Incomplete | 1 | 4578 | XXXX | YYY |
| Heart Rate | In Use | 3 | 4190 | XXXX | YYY |
| White Cell Count | In Use | 5 | 1789 | XXXX | YYY |
| Serum Glucose | DSTU | 2 | 3675 | XXXX | YYY |
| Serum Bilirubin | In Use | 3 | 5367 | XXXX | YYY |

Model Adoption

| Model Id | Realm | Use Case | Meta data |
|---|---|---|---|
| Heart Rate | US | Public Health Reporting | YYY |
| Hematocrit | AUS | Standard Lab Results | YYY |
| Serum Glucose | US | MU Quality Measure | YYY |
| Serum Glucose | International | CIMI | YYY |
| Serum Glucose | International | openEHR | YYY |
| Serum Bilirubin | HSPC | Neonatal Bilirubin App | YYY |

# The path to interoperability

# What is HL7 FHIR©®?

- A set of modular components called "Resources"
- Resources refer to each other using URLs
  - Build a web to support healthcare process
- Exchange resources between systems
  - Using a RESTful API (e.g. web approach)
  - As a bundle of resources (messages, documents)

# FHIR: Core Resources

AdverseReaction
Alert
AllergyIntolerance
CarePlan
Composition
ConceptMap
Condition
Conformance
Device
DeviceObservationReport
DiagnosticOrder
DiagnosticReport
DocumentReference
DocumentManifest
Encounter
FamilyHistory
Group
ImagingStudy
Immunization
ImmunizationRecommendation
List
Location
Media
Medication
MedicationAdministration
MedicationDispense
MedicationPrescription
MedicationStatement
MessageHeader
Observation
OperationOutcome
Order
OrderResponse
Organization
Other
Patient
Practitioner
Procedure
Profile
Provenance
Query
Questionnaire
RelatedPerson
SecurityEvent
Specimen
Substance
Supply
ValueSet

# Example: Fetch a systolic blood pressure

```
GET https://open-api.fhir.me/Observation/8567?_format=json
```


```
{
  "resourceType": "Observation",
  "text": {
    "status": "generated",
    "div": "<div>1999-07-02: Systolic blood pressure = 109 mm[Hg]</div>"
  },
  "name": {
    "coding": [
      {
        "system": "http://loinc.org",
        "code": "8480-6",
        "display": "Systolic blood pressure"
      }
    ]
  },
  "valueQuantity": {
    "value": 109.0,
    "units": "mm[Hg]",
    "code": "mm[Hg]"
  },
  "appliesDateTime": "1999-07-02",
  "status": "final",
  "subject": {
    "reference": "Patient/1186747"
  }
}
```


Resource (unique) ID

Resource Type

Semantics

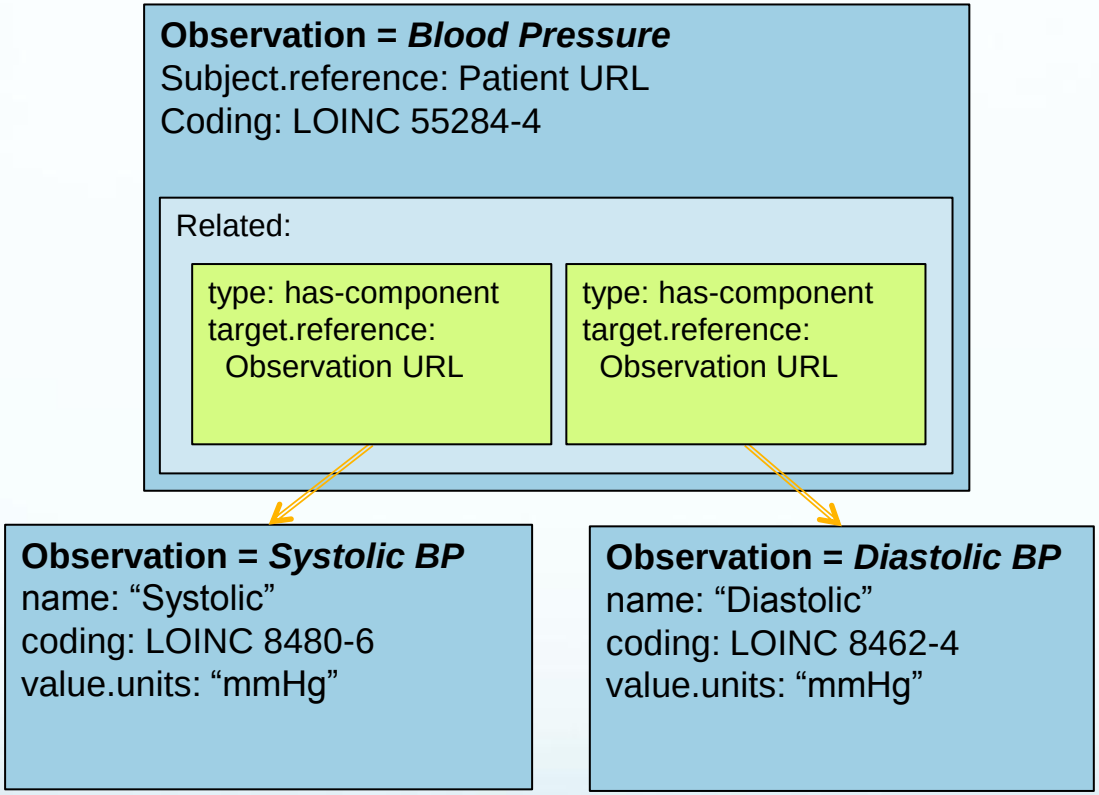
Clinical Values

URL to Patient

# Observation Resource

**Observation (DomainResource)**
identifier : Identifier [0..*]status : code [1..1]« ObservationStatus! »
code : CodeableConcept [1..1] « LOINC ?? »
subject : Reference [0..1]« Patient|Group|Device|Location »
encounter : Reference [0..1] « Encounter »
effective[x] : Type [0..1]« dateTime|Period »
value[x] : Type [0..1]
« Quantity|CodeableConcept|string|Range|Ratio|SampledData|
Attachment|time|dateTime|Period »
interpretation : CodeableConcept [0..1] « Observation Interpretation+ »
method : CodeableConcept [0..1] « Observation Methods?? »
specimen : Reference [0..1] « Specimen »
device : Reference [0..1] « Device|DeviceMetric »

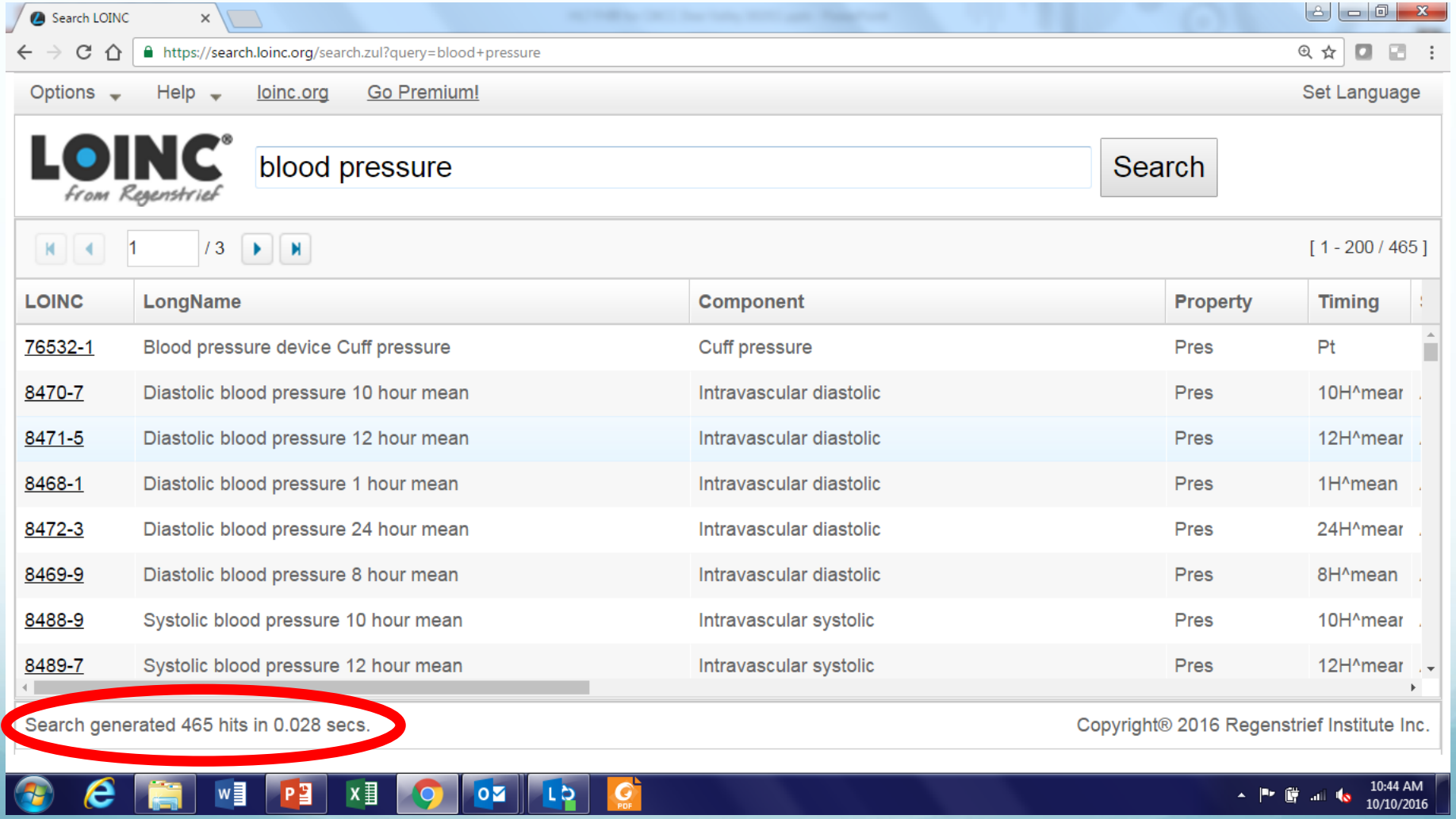
# Profile for "Blood pressure"



# Progress

- FHIR is easy to implement
- FHIR has unprecedented support from EHR vendors
- SMART on FHIR Applications at Intermountain Healthcare
  - In use - Pediatric growth chart, Pediatric drug card, BP Centiles
  - In development - HIE viewer, Pulmonary Embolus diagnosis and management
  - University of Utah collaborations
    - ONC Challenge grant: Neonatal bilirubin app
    - ONC High Impact grant: Surgery transition app

# LOINC Codes for Blood Pressure



# The danger

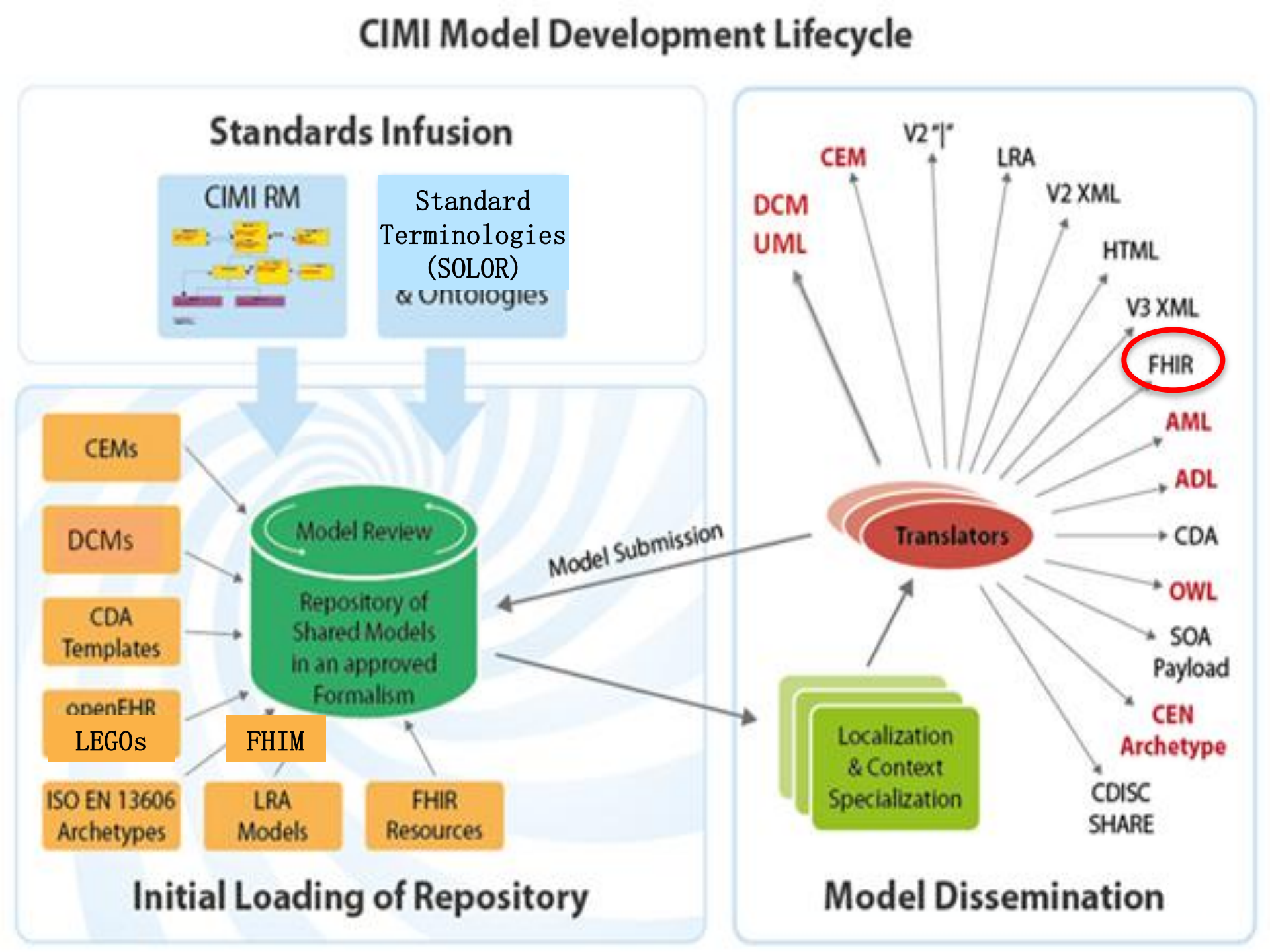
- No true interoperability because
  - Vendors use different models/profiles
  - Government agencies use different models/profiles
  - Provider organizations use different models/profiles
  - Professional organizations use different models/profiles

# CIMI

- The Clinical Information Modeling Initiative (CIMI) is an HL7 Work Group that is producing detailed clinical information models to enable interoperability of health care information systems
- CIMI was initiated during a "Fresh Look" session at an HL7 meeting in 2011
- CIMI models are free for use for all purposes
- See http://www.opencimi.org/ for more details

# CIMI Goals

- Create a shared repository of detailed clinical information models
- Repository is open to everyone and models are licensed free for use at no cost
- Where the models:
  - Are expressed in an approved formalism
    - Archetype Definition Language (ADL)
    - Archetype Modeling Language (AML)
  - Are based on a core reference model, including a set of base data types
  - Have formal bindings to standard coded terminologies


CIMI Model Development Lifecycle
Standards Infusion
CIMI RM
Standard Terminologies (SOLOR)
& Ontologies
CEMs
DCMs
CDA Templates
openEHR LEGOs
ISO EN 13606 Archetypes
FHIM
LRA Models
FHIR Resources
Model Review
Repository of Shared Models in an approved Formalism
Model Submission
Initial Loading of Repository
Translators
Localization & Context Specialization
CEM
V2 "|"
LRA
V2 XML
DCM
UML
HTML
V3 XML
FHIR
AML
ADL
CDA
OWL
SOA Payload
CEN Archetype
CDISC SHARE
Model Dissemination

# Healthcare Services Platform Consortium

## MISSION

Improve health by creating a vibrant, open ecosystem of interoperable applications, content, and services

# Membership

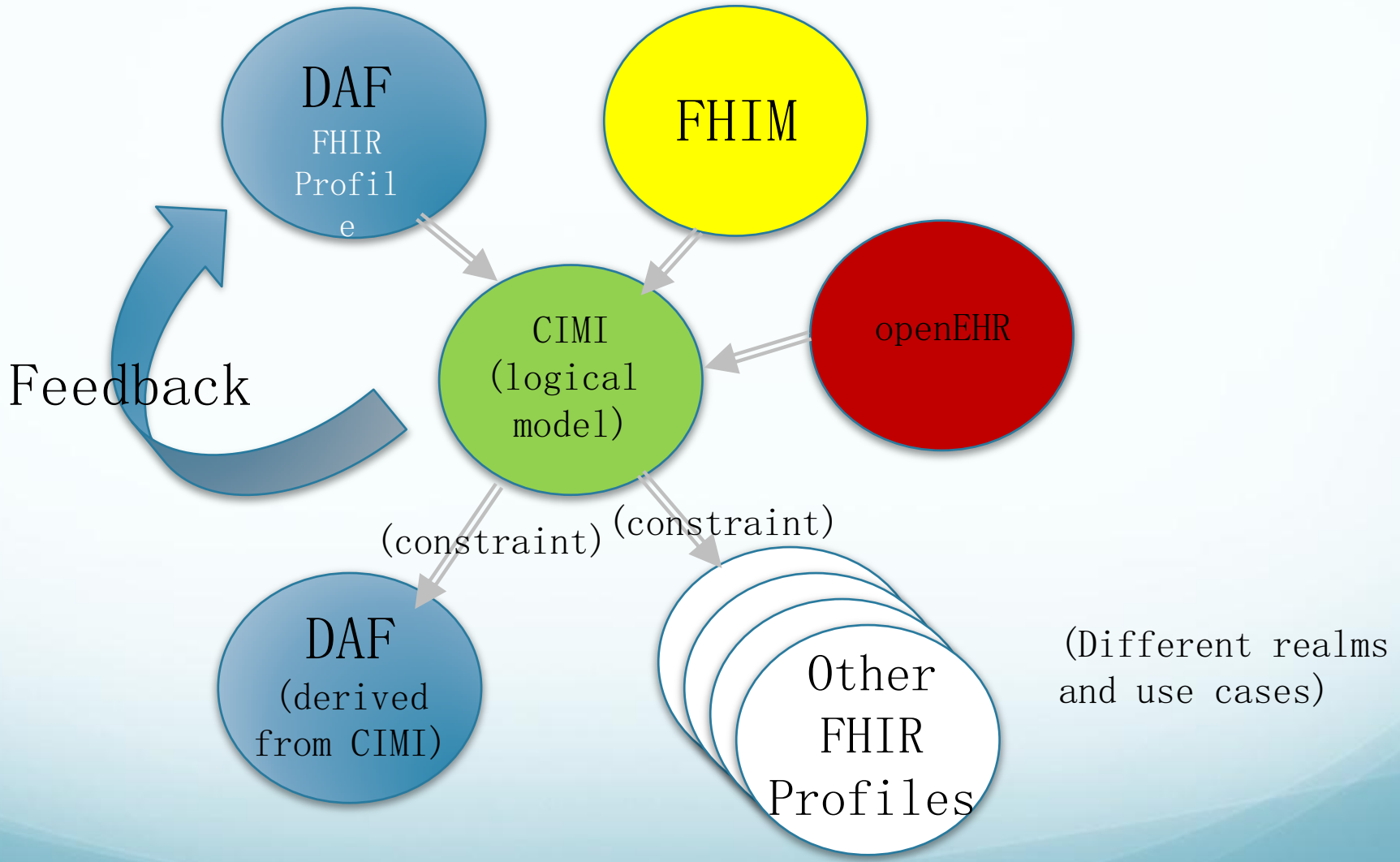
- 3 Benefactor members
  - Veterans Administration
  - Louisiana State University Health
  - Intermountain Healthcare
- Key alliances
  - Center for Medical Interoperability (C4MI)
  - OSEHRA
- 3 Associate (organizational) members
  - Regenstrief
  - Motive
  - Allscripts
- 11 Individual members
- Society Members: AMA, MHII and ACOG

# HSPC Initiatives

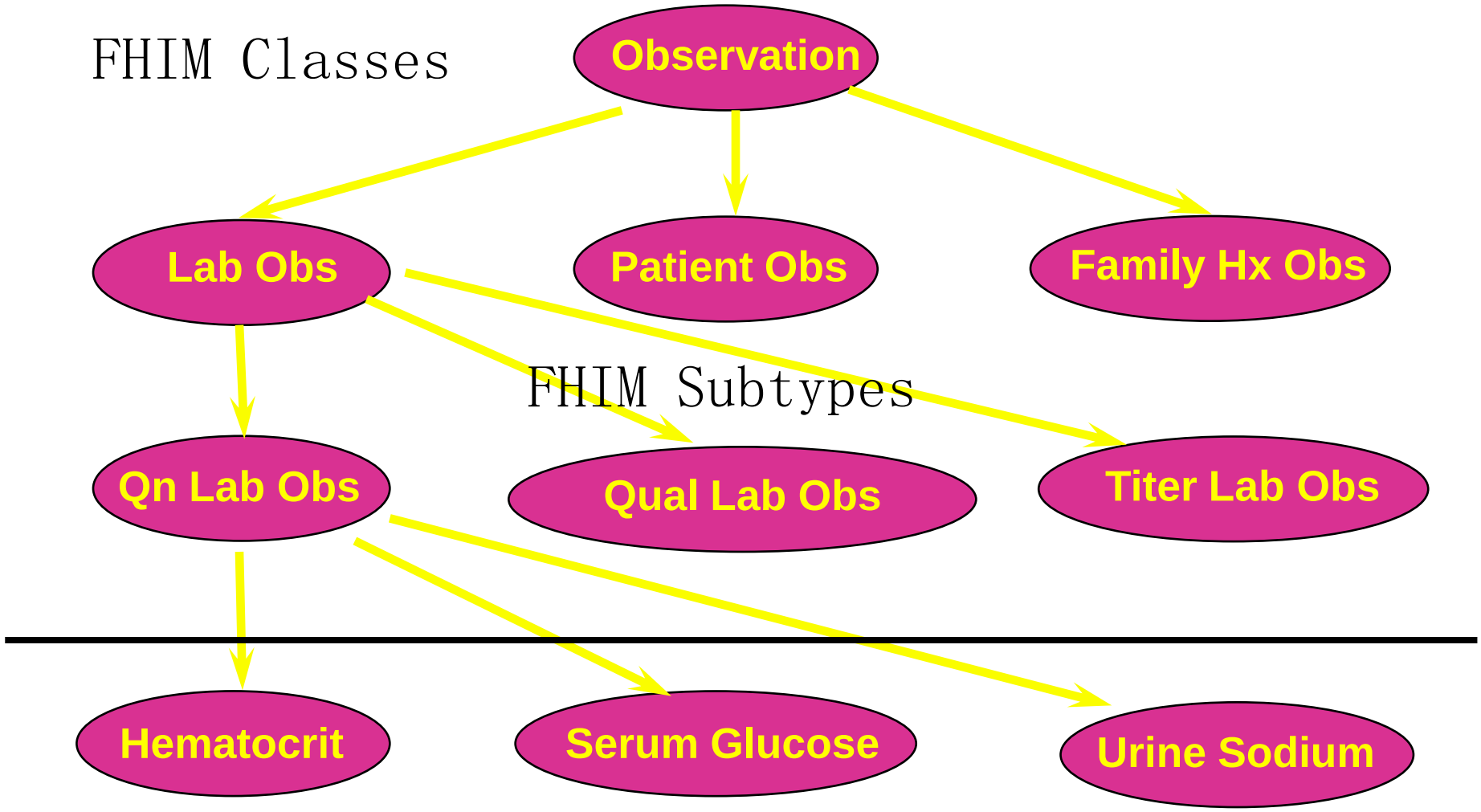
- Be a provider led collaboration agent
- Create a reference implementation of common SOA
- Develop terminology and information models for true semantic interoperability
- Support authoring and sharing of knowledge content
- Obtain implementation and adoption of approved standards
- Create a shared technical environment to enable simple and efficient development

# Appendix

# Working with FHIR Resource Owners



# Value Add from CIMI




Invariant Profile Structure – CIMI Leaf Node Co

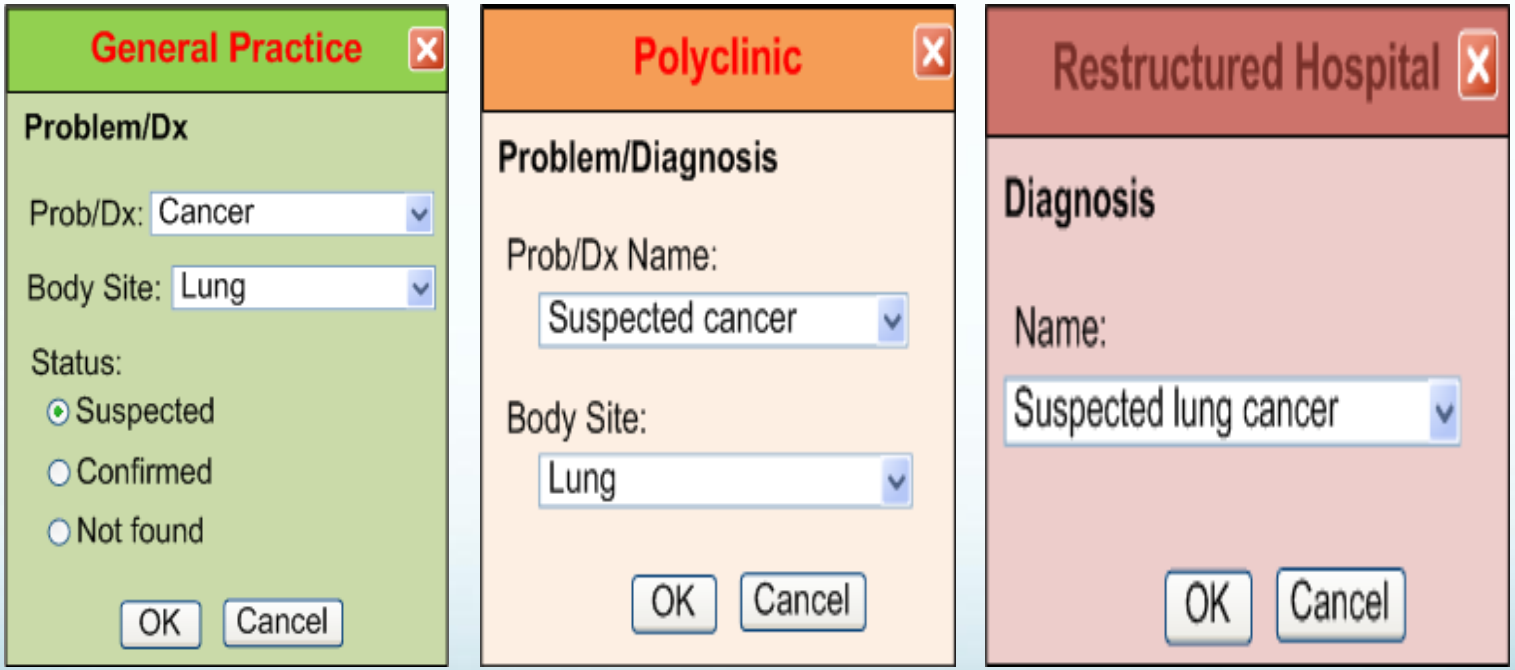
# Argonauts and CIMI

- We agree with the need for everything the Argonauts are doing
- Current scope of the Argonaut work will not achieve true plug-n-play interoperability
  - Meaningful use common data elements
  - DAF profiles (high level profiles)
  - Small number of detailed models
    - Vital signs (measurements only, no qualifying information)
- CIMI adds detailed content for plug-n-play interoperability
  - Lab measurements
  - Patient measurements
  - Physical exam
  - Intake and Output
  - Assessment instruments: Apgars, Braden, Pain Scales, etc.

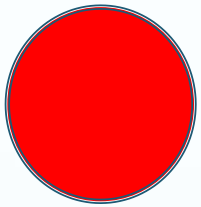
# IsoSemantic Models – Example of Problem

*(from Dr. Linda Bird)*

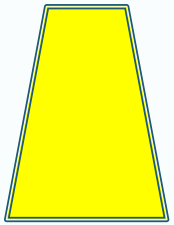
**e.g. "Suspected Lung Cancer"**



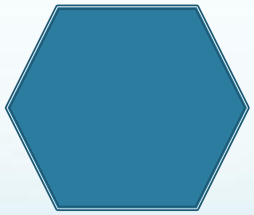
# Data Comes in Different Shapes and Colors



Finding – Suspected Lung Cancer

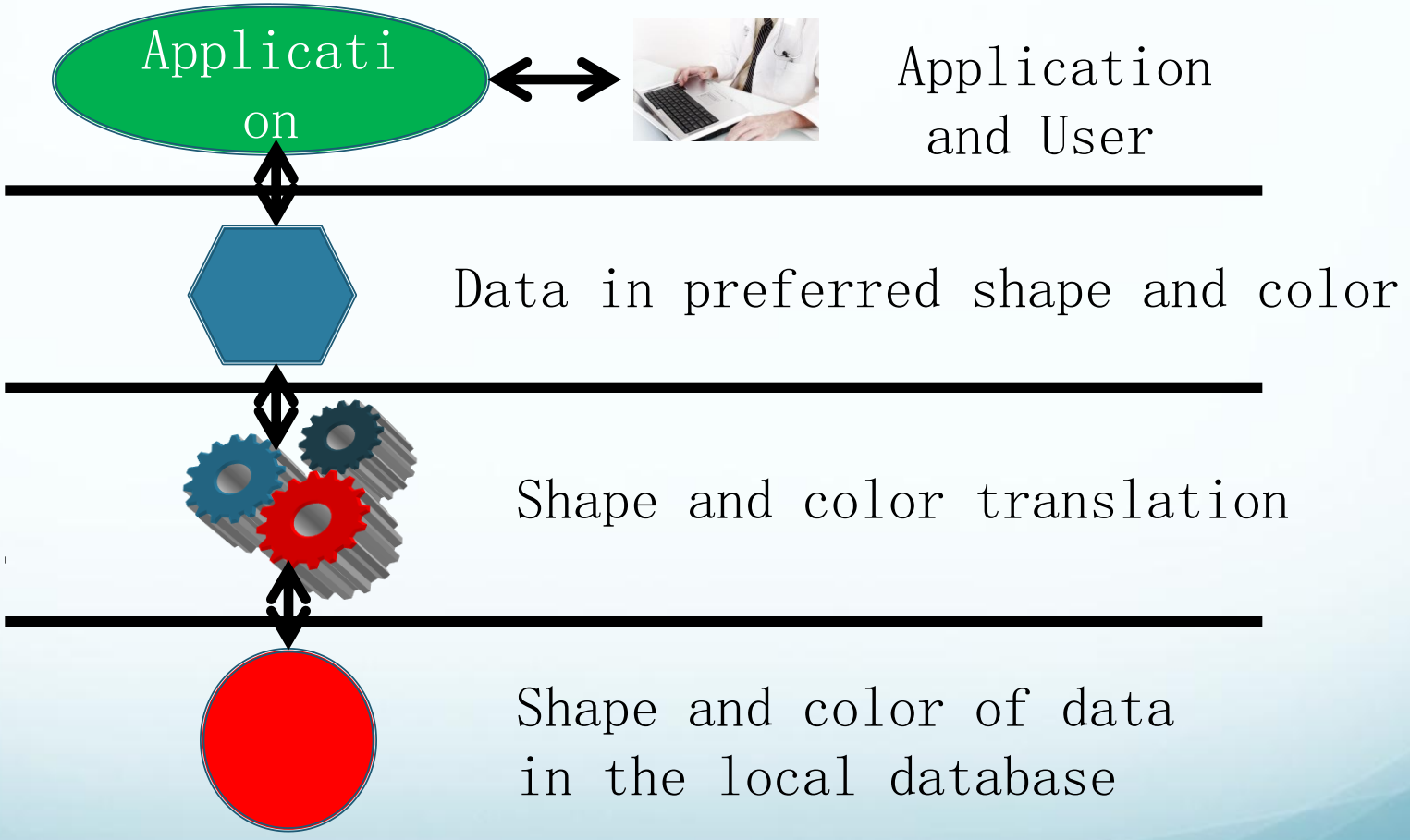


Finding – Suspected Cancer
Location – Lung

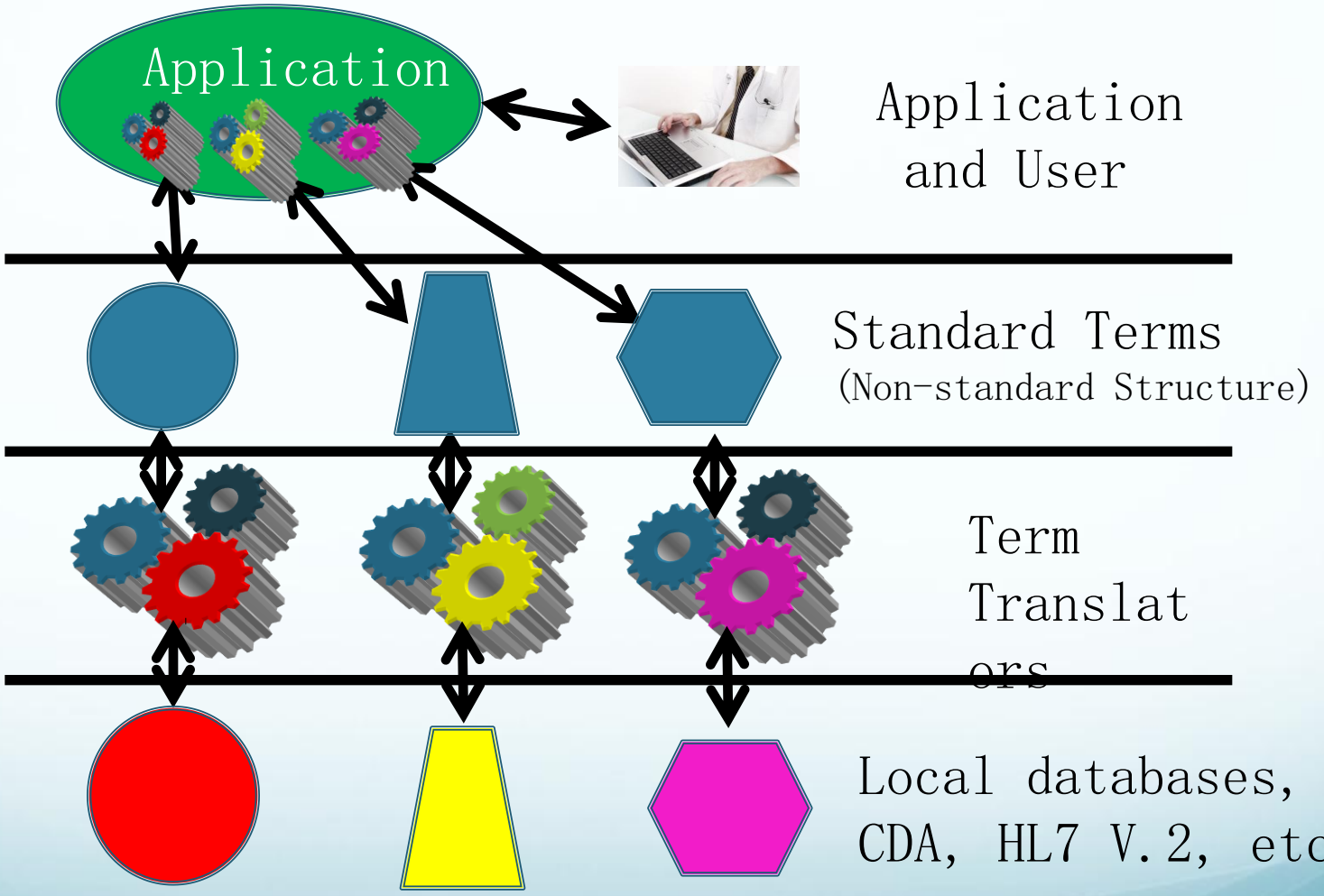


Finding – Cancer
Location – Lung
Certainty – Suspected
(Let's say this is the preferred shape

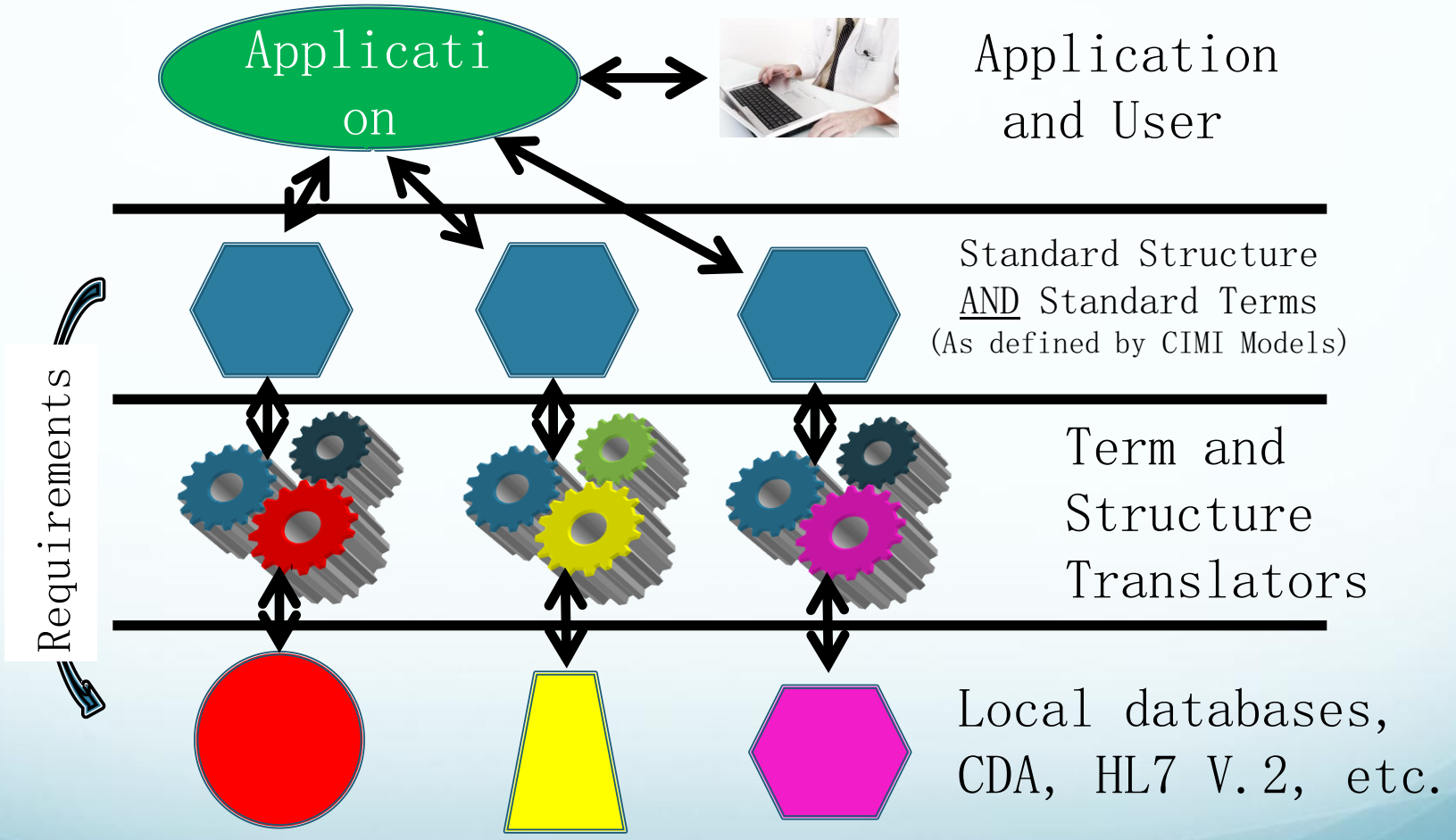
# Data Standardized in the Service



# Partial Interoperability



# Preferred Strategy – Full Interoperability



# Reasons to do it on the server side

- Person writing the translation is most likely to understand the meaning of the data in their own database.
- The person writing the translation only has to understand their own data and the preferred model.
  - They can optimize query execution for their own system
- The query for the data is simpler. If the application has to write a query that will work for all shapes, the query will be inefficient to process by every system.

# The Value of "Truly" Interoperable Systems

# The cost of medical software

- Becker's Health IT & CIO Review
  - Partners HealthCare: $1.2 billion

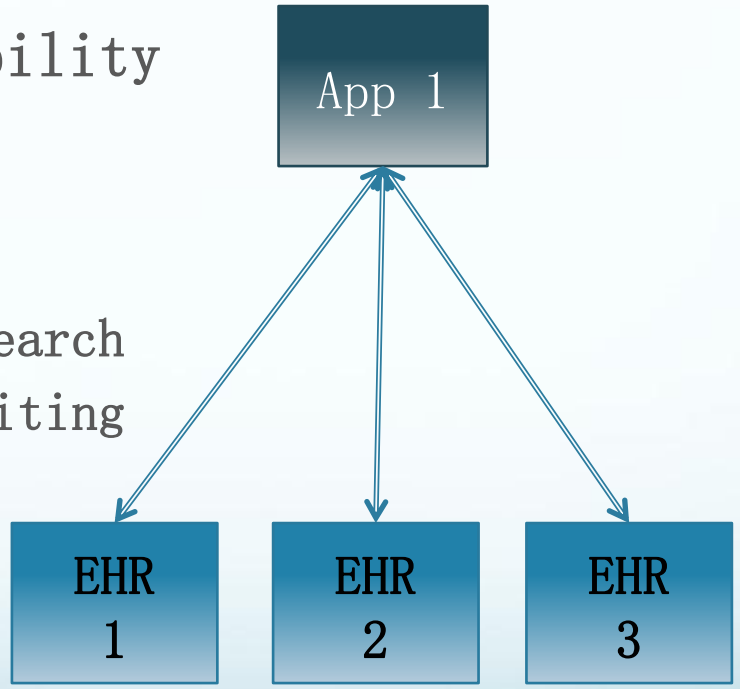
    Boston-based Partners HealthCare is one of more recent implementations, going live the first week of June to the tune of $1.2 billion. This is the health system's biggest investment to date. The implementation process took approximately three years, and in that time, the initial price tag of $600 million doubled.

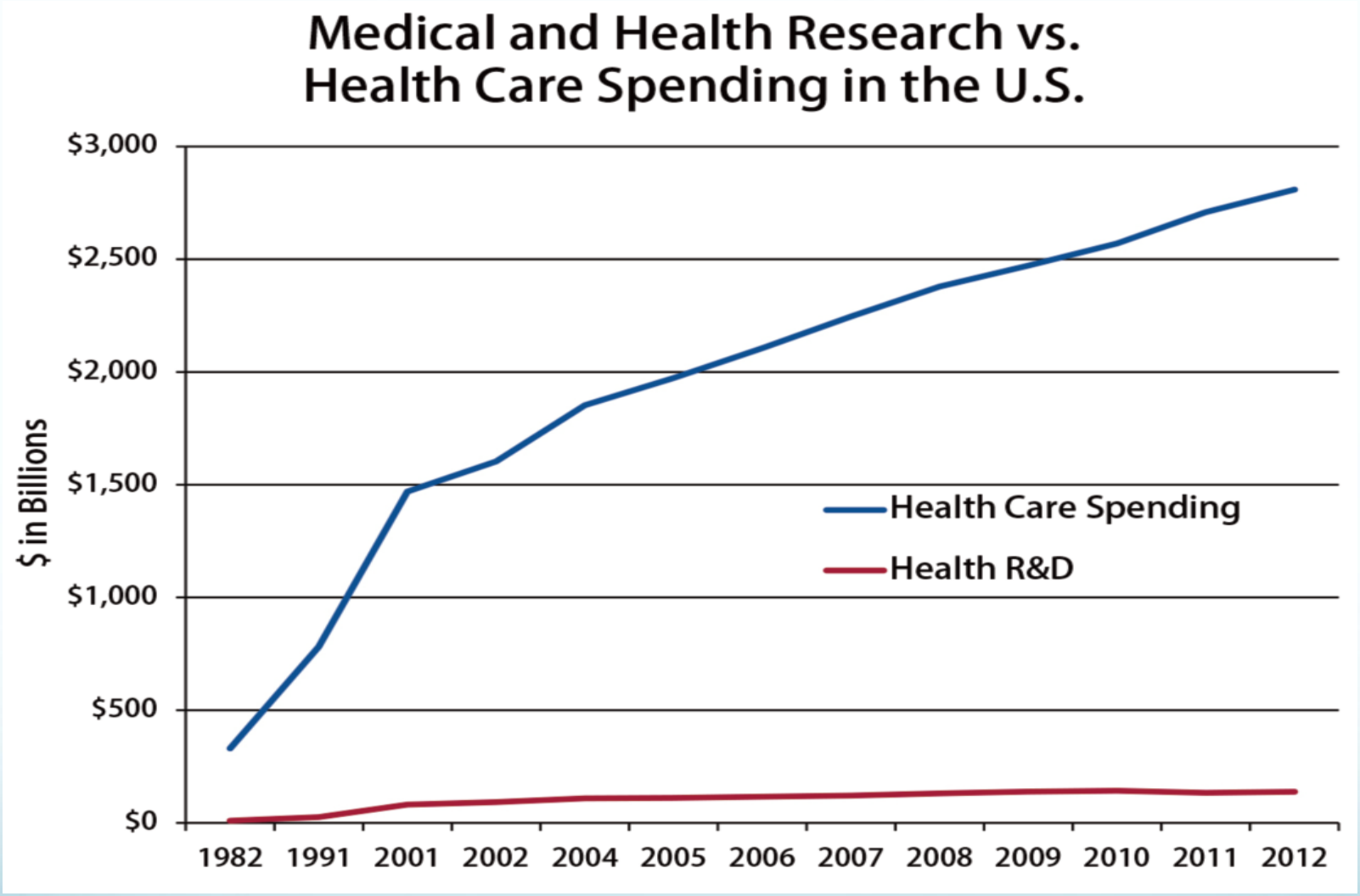
- Intermountain Medical Center $550 million

# ACOs and Registries

Apps that enable data sharing…

- Next-gen Interoperability
  - Population Health integration
  - HIE integration
  - Data capture for research
  - Clinical Trial recruiting
  - Quality Repositories






(from Research America)

The start of a Learning Healthcare System is accurate, computable, data.

# More Reasons

- Agile software development
  - Widely distributed
  - Directed daily by front line clinicians
  - Increased usability of software, creativity, innovation
- Increased choice in software
  - Thousands of independent developers
  - Centrally planned economy vs free market
  - Think “app store for healthcare” or of innovations like Uber