IBM Research

Towards a National Health Information Network

Sarah Knoop

IBM Almaden Research Center

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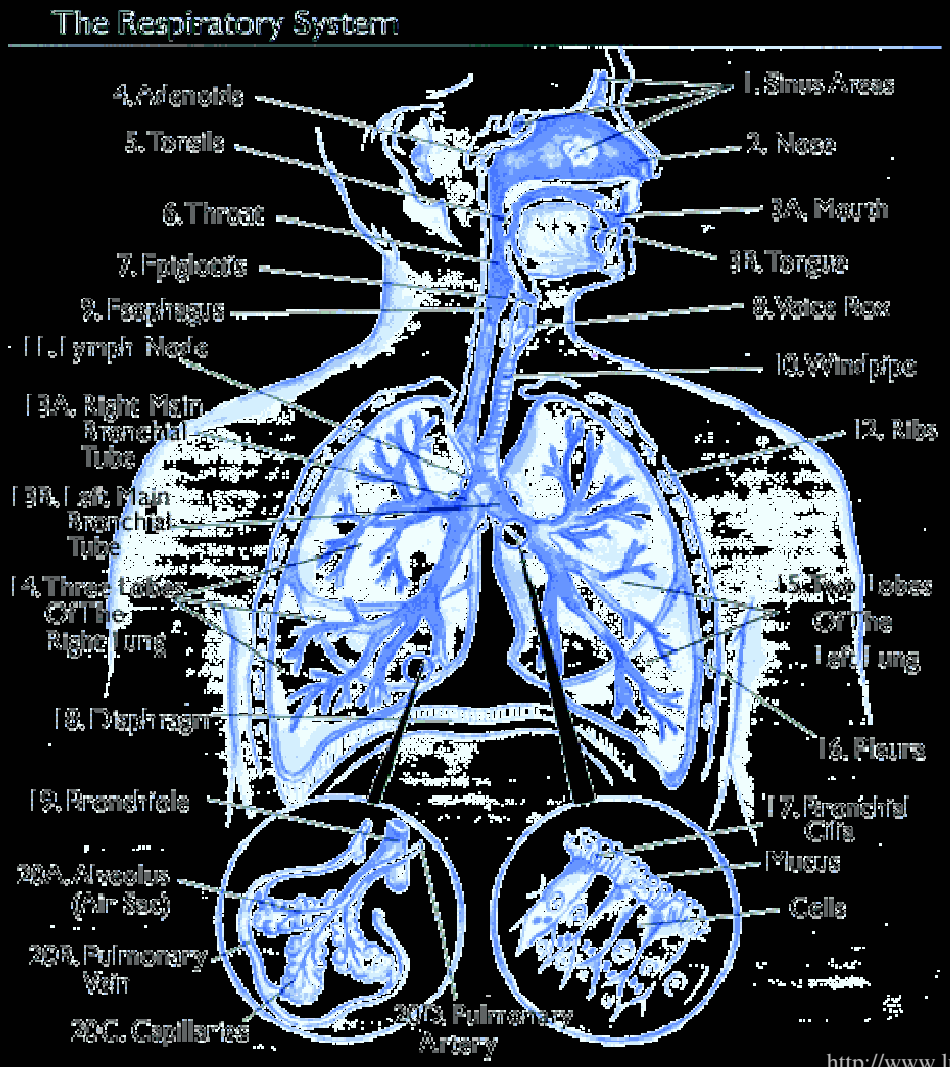
Ellen's Story



http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=22576

Brewing of the Perfect Storm

- The U.S. spends nearly $1.9 Trillion (2004) on healthcare
  - More the twice the per person expense of any western nation
  - Medicare + Medicaid: largest or second largest line item expense on the budget of every state in the union
- Small Medium Clinics (SMCs) have only a 12% adoption rate for EMR systems, while the rest still use antiquated paper forms and filing systems
- Britain will spend over $6.3 B£ to create a longitudinal EHR
  - Canada, Australia, Finland, other countries have similar efforts

Bottom Line:

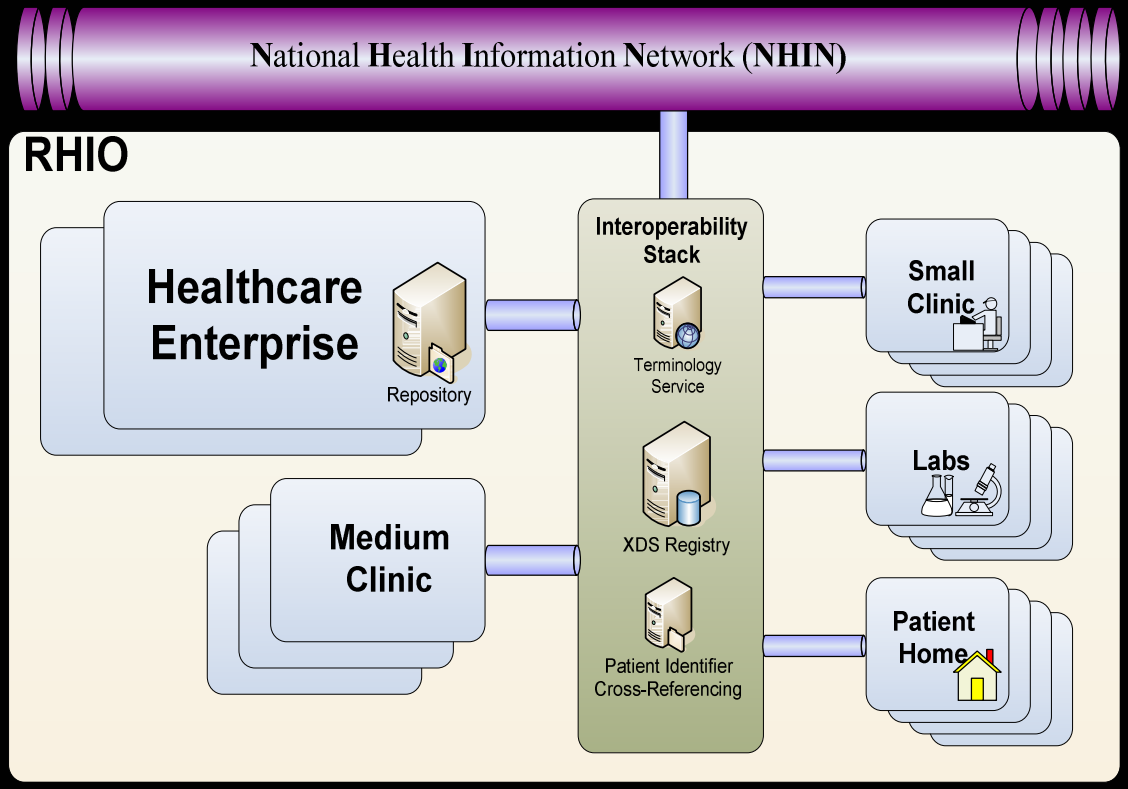
- Healthcare data and costs are no longer manageable by current systems. The industry is looking towards IT infrastructure and applications for aid.
- Interoperable healthcare IT systems that allow for the sharing of data are vital to the solution.

Outline

- Key Technical Challenges of Interoperability in Healthcare
- Lowering the Barriers to Interoperability
- Infrastructure for interoperability
- Developers Community
- Exemplary Application (STEM)

Towards NHIN - Interoperability

"Ability of two or more systems or components to exchange information and to use the information that has been exchanged"
[IEEE Standards Computer Dictionary]

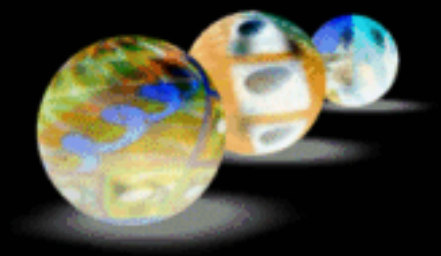


Interoperability Challenges

- The biggest challenges to sharing data are accessing it and understanding it
- Barriers today:
  - Proprietary data formats
  - Proprietary access protocols

Lowering the Barriers to Interoperability

- Infrastructure
  - Ex. Good old servers



- Standards
  - Ex. HL7, DICOM, Standards based IHE profiles

DICOM
Digital Imaging and Communications in Medicine
HL7 IHE

- Developers Community
  - Ex.Eclipse Open Source

eclipse

Internet Analogy

- Infancy of internet dealt with competing low-level protocols and data formats.
- Standardization of these protocols (TCP/IP) and data formats (HTML, XML) lead to development of free browsers, thereby opening up the internet's full potential.
- One of the first instances in which it took a community to develop all the technology needed. The community remains intimately tied to the technology.

IHE

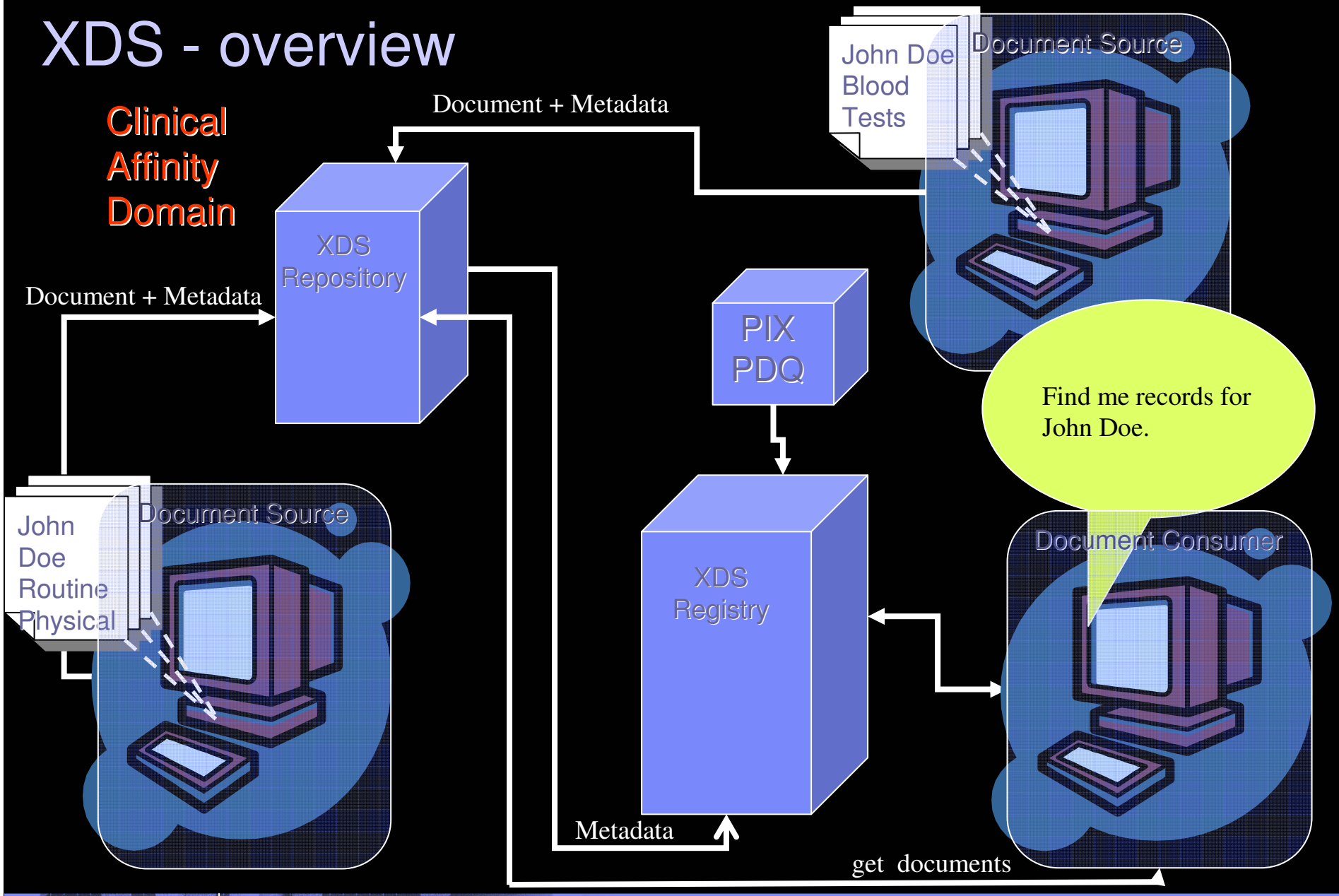
- Integrating the Healthcare Enterprise
  - "initiative by healthcare professionals and industry to improve the way computer systems in healthcare share information" *
  - Not creator of standards, rather an integrator (form "profiles")
  - areas of focus include radiology, cardiology, patient care coordination, technical framework.

www.ihe.net

XDS

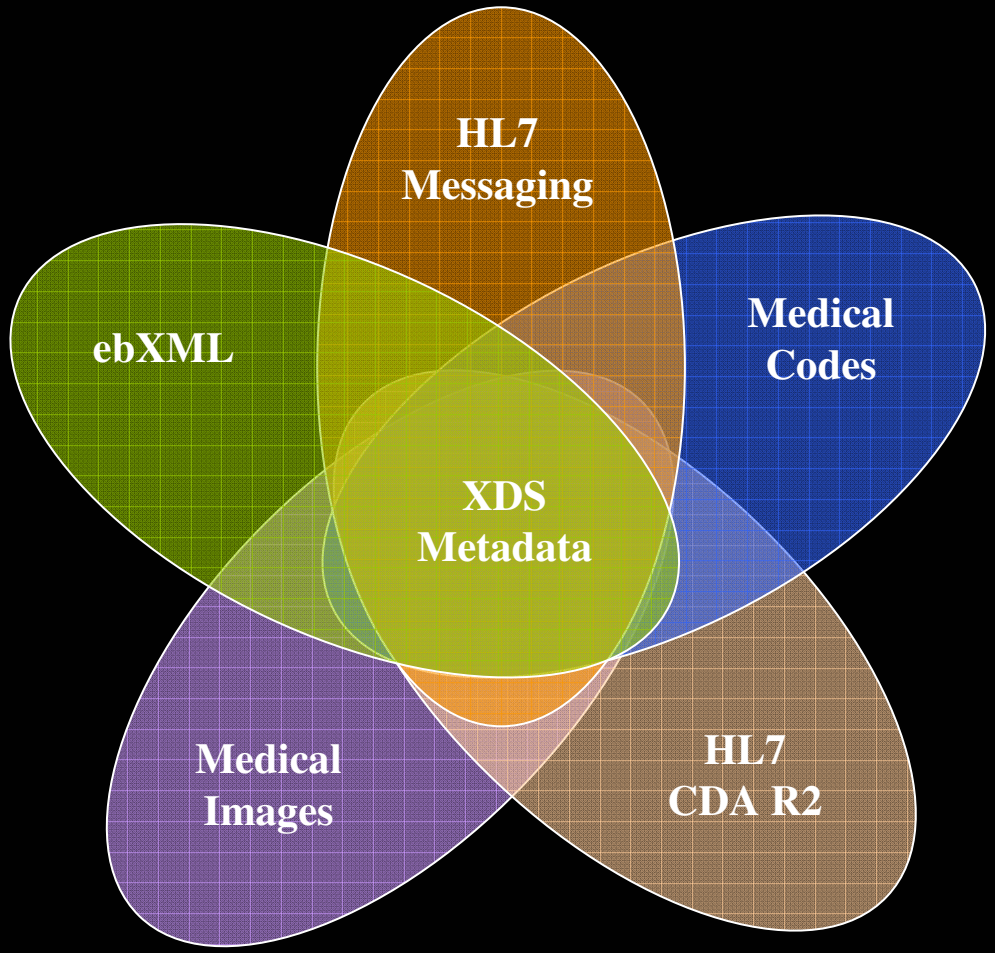
- Cross-Enterprise Document Sharing (XDS)
  - Standards based architecture for sharing of clinical documents among healthcare enterprises
  - Based on ebXML registry, SOAP, TLS

XDS - overview



IHE's XDS Metadata

- Define concepts central to sharing healthcare data
- Integrate diverse *standards and data models* to create a common healthcare metadata registry
- Patient Centric



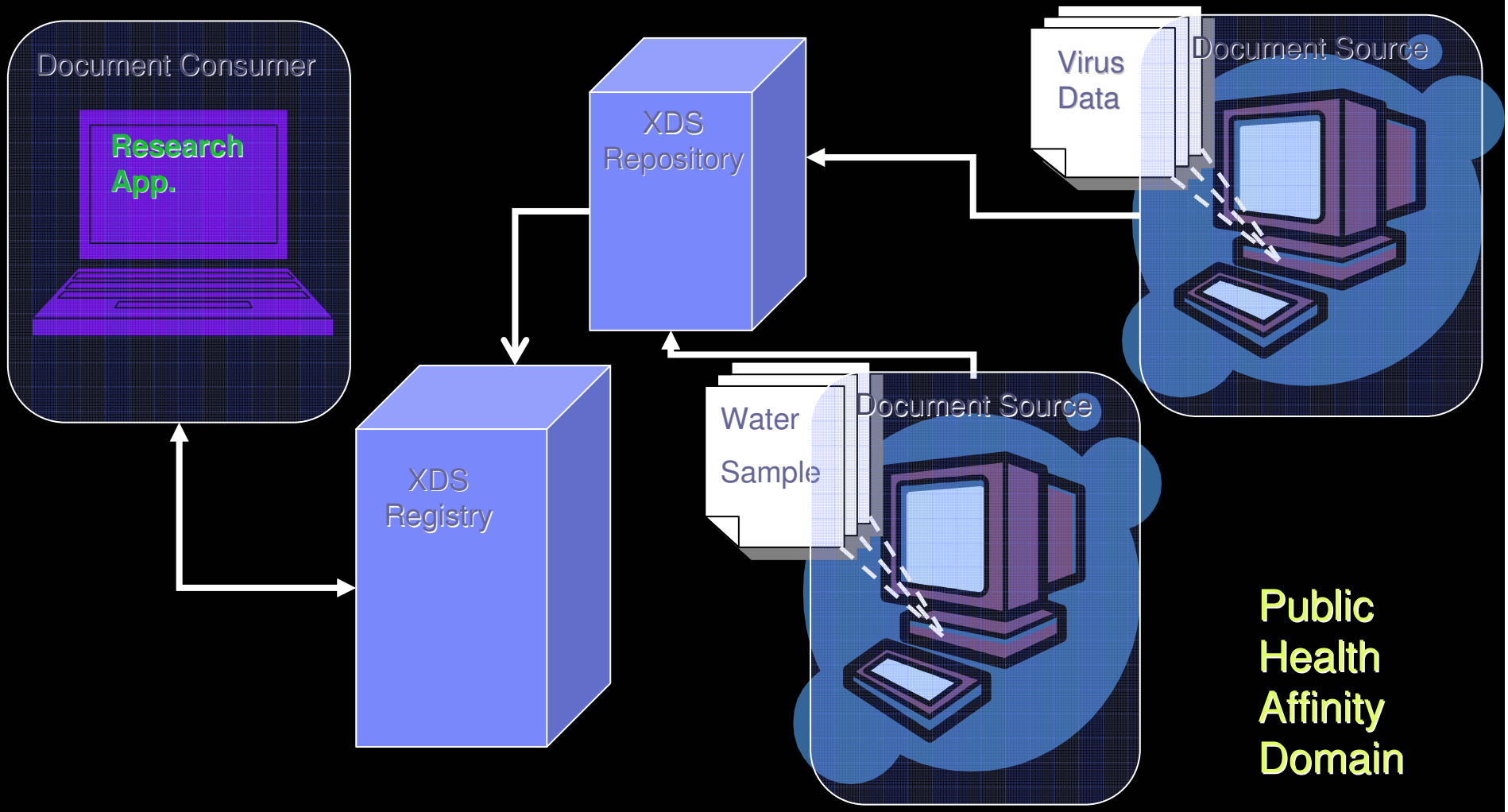
The upside …

- Most of the XDS metadata concepts have nothing to do with individual patients.
- The essential aspects of the actors, transactions and underlying technologies (ebXML, SOAP, etc.) of XDS are not patient centric.
- We can re-focus XDS around a more general concept ("entity") and still adhere to the majority of the XDS profile. The same architecture that serves clinical care can be used to support clinical research, public health and biosurveillance.

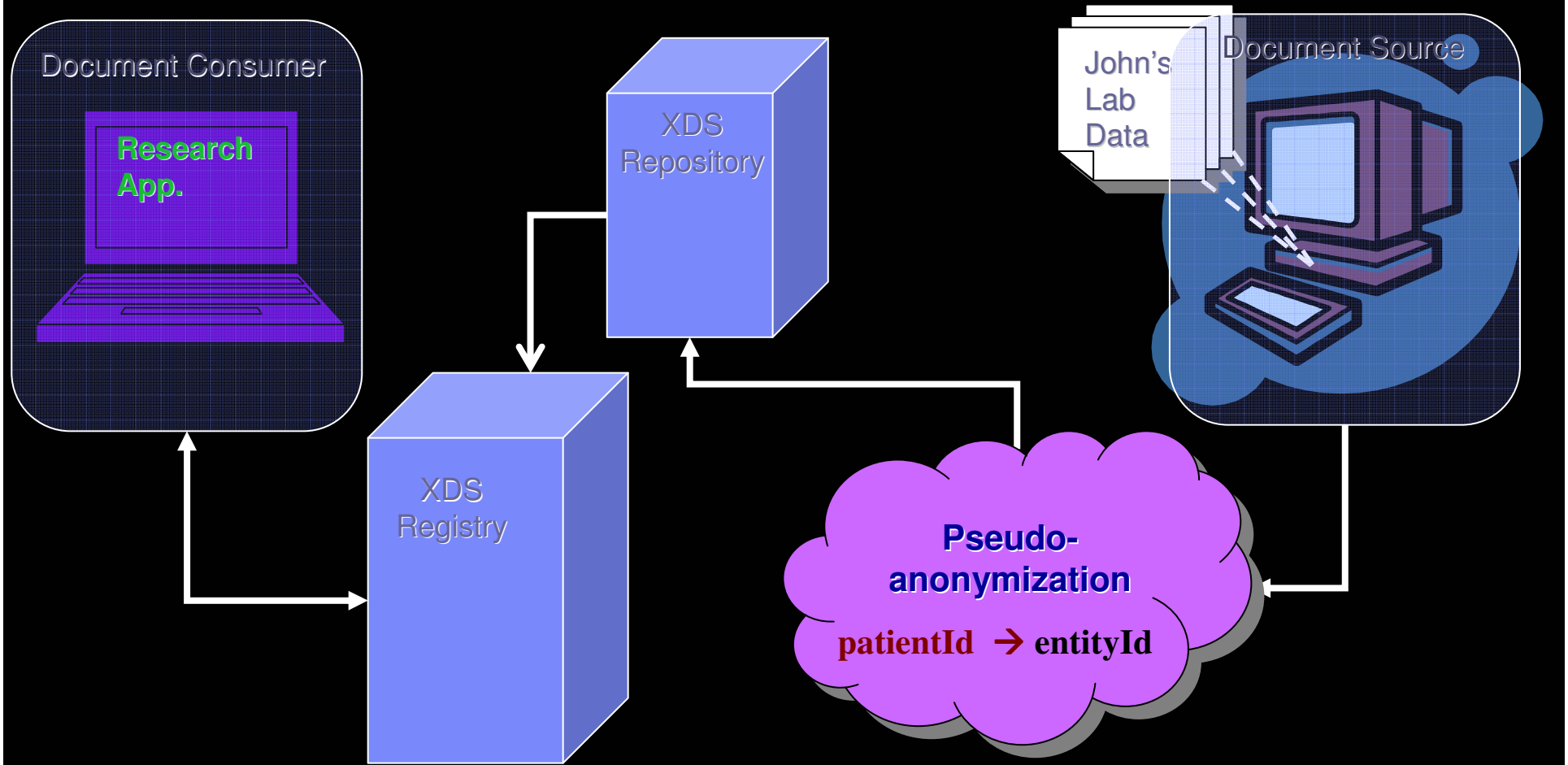
Possible Entities

- Patients
- Lab specimens (body fluids, etc.)
- Virus, bacteria
- Air samples
- Soil samples
- Water samples
- Etc.

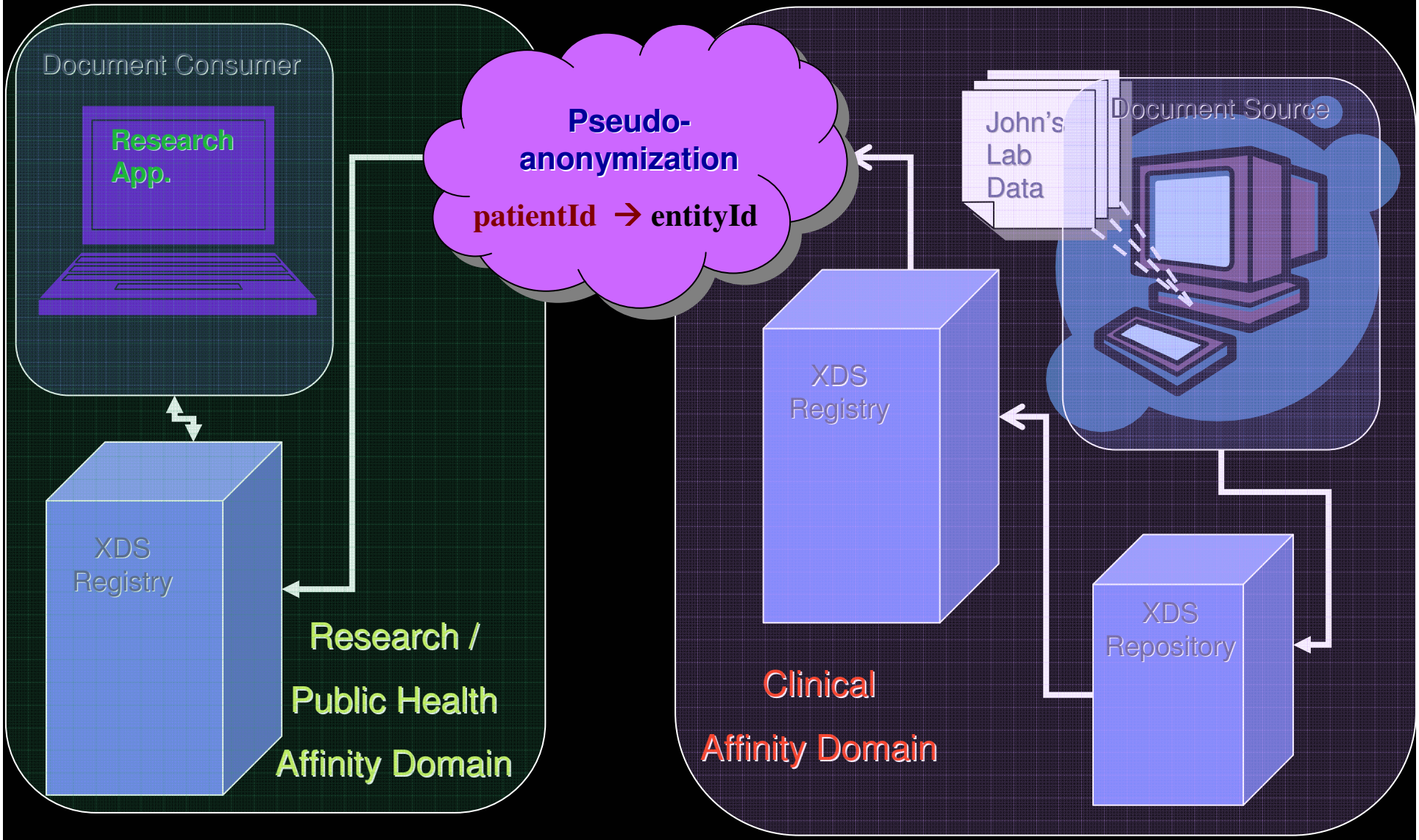
Use a source “entity”-centric XDS to pool data for research, public health and biosurveillance.



A Special Consideration – Patient Identifiable Data



Connecting Private and Public Health



Realization of Interoperability

- Implementation and adoption of standards for healthcare document modeling and exchange is vital.
  - Analogous to the evolution of the Internet
- Open source software has the potential to accelerate the achievement of this goal by creating a community of healthcare technology and information technology professionals to implement and maintain up-to-date IT standards needed for healthcare interoperability.

Eclipse Open Healthcare Framework

- The Eclipse Foundation
  - Open source community whose projects are focused on providing an extensible development platform and application frameworks for building software.
  - www.eclipse.org
- The Eclipse Open Healthcare Framework (EOHF)
  - project within Eclipse formed for the purpose of expediting healthcare informatics technology.
  - extensible frameworks and tools which emphasize the use of existing and emerging standards in order to encourage interoperable open source infrastructure, thereby lowering integration barriers.
  - www.eclipse.org/ohf

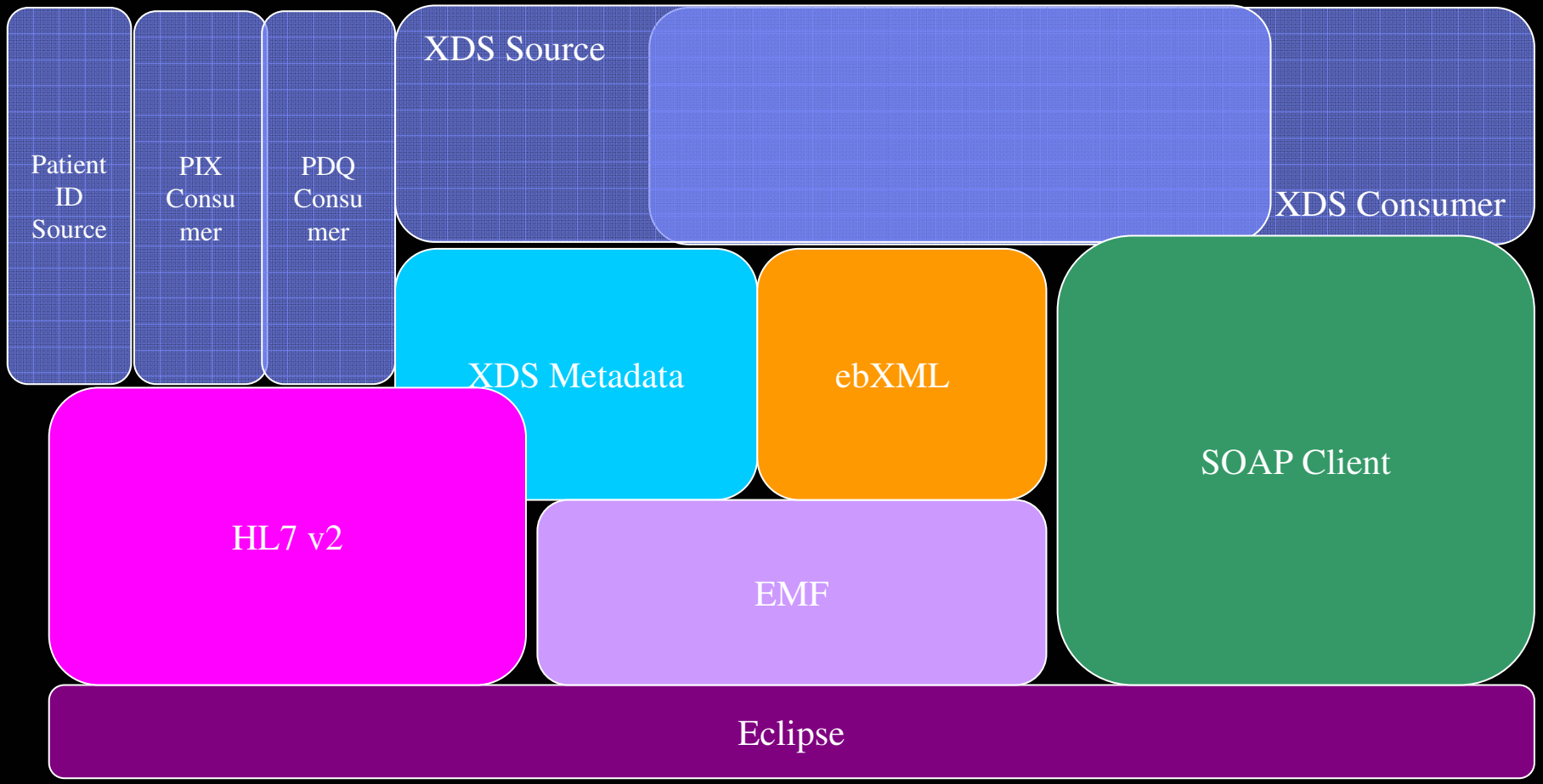
Initial Contributions to EOHF

- Mayo Clinic
  - –Implementation of the HL7 Common Terminology Service API
- Jiva Medical
  - –HL7 V2.x and V3 messaging models and tools
- Inpriva
  - – Security, Auditing, Authentication Framework components
- IBM
  - – XDS and PIX/PDQ client side actors, Web Service “bridge” to these actors, WADO client and STEM

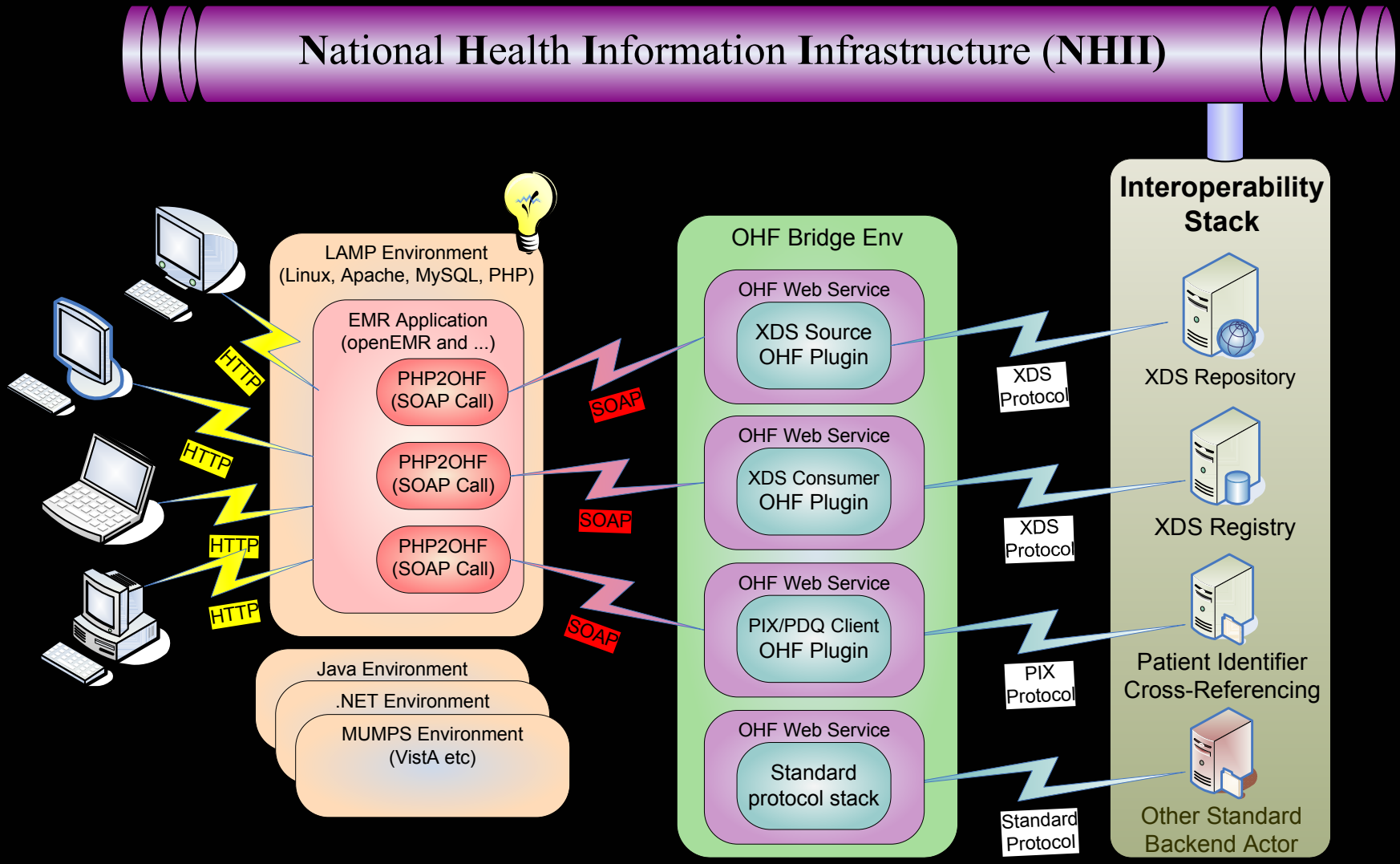
Eclipse Plugin Model

- Architectural pattern for building an application from constituent parts
- Contributions to the Eclipse platform are made by wrapping code, etc. in pluggable components, called *Eclipse plug-ins*, which conform to Eclipse's plug-in contract.
  - Extensibility: new plug-ins can add new processing elements to existing plug-ins
- Eclipse Platform provides the basics needed to boot-strap the whole process.

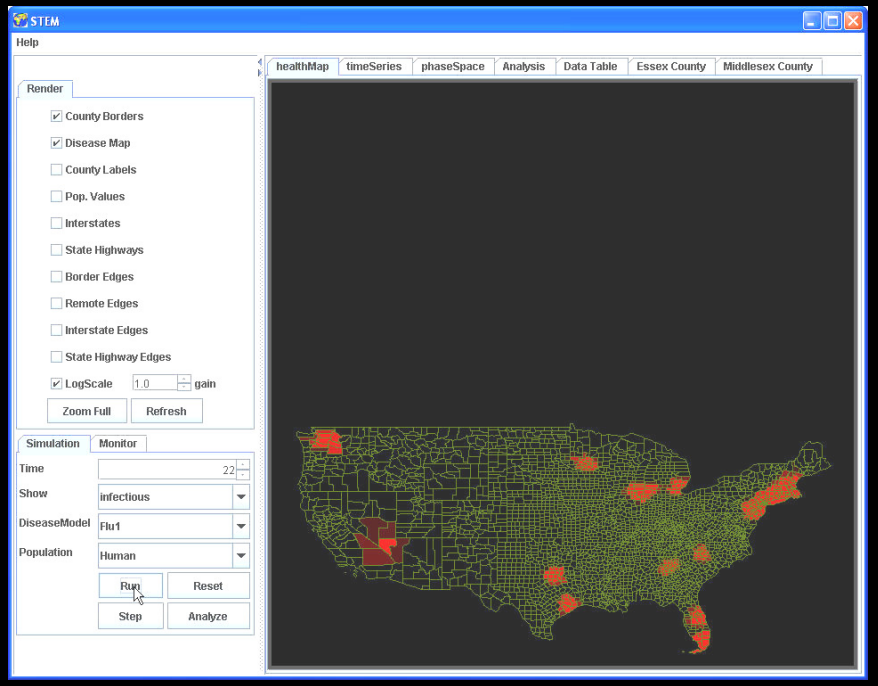
Eclipse Plugin Model - Example



OHF Bridge – Moving Eclipse to Server Side



STEM



"An extensible spatial and temporal epidemiological modelling system", Daniel Alexander Ford, James H Kaufman and Iris Eiron

International Journal of Health Geographics 2006, 5:4 (17January 2006)
http://www.ij-healthgeographics.com/content/5/1/4

Motivation

Liberty Loan parade, Philadelphia, Sept 28, 1918

US Naval Historical Center, Image NH 41730

Philadelphia, October 1918

"Corpses were wrapped in sheets, pushed into corners, left there sometimes for days, the horror of it sinking in deeper each hour, people too sick to cook for themselves, too sick to clean themselves, too sick to move the corpse off the bed, lying alive on the same bed with the corpse. The dead lay there for days, while the living lived with them…

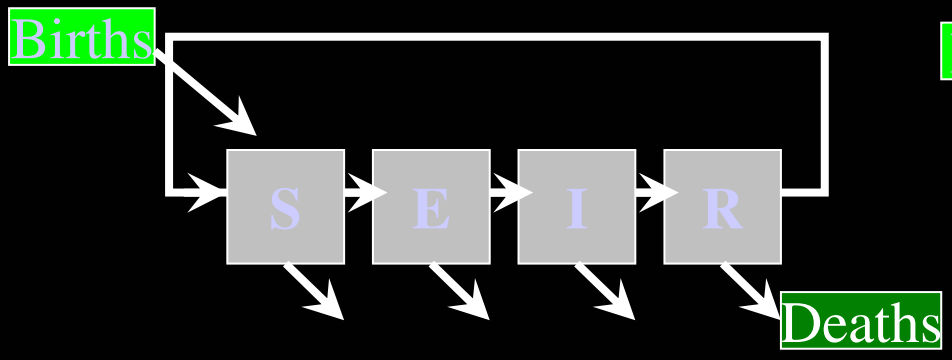
"…cyanosis was so extreme, turning some victims so dark—the entire body could take on color resembling that of the veins on one's wrists—it sparked rumors that the disease was not influenza at all, but the Black Death."

- John M. Barry, "The Great Influenza"

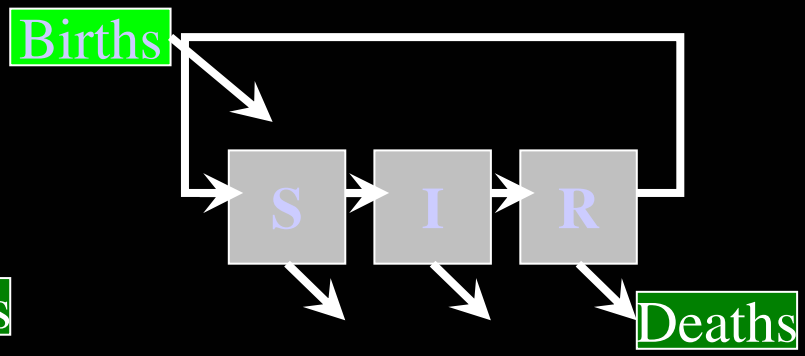
National Museum of Health and Medicine, Washington, D.C., Image NCP 1603

Epidemiological Models

Standard SEIR model

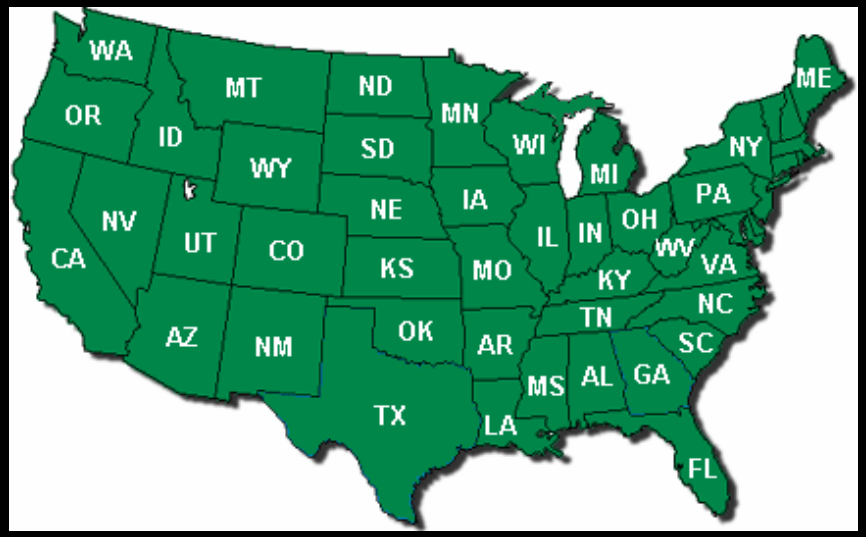


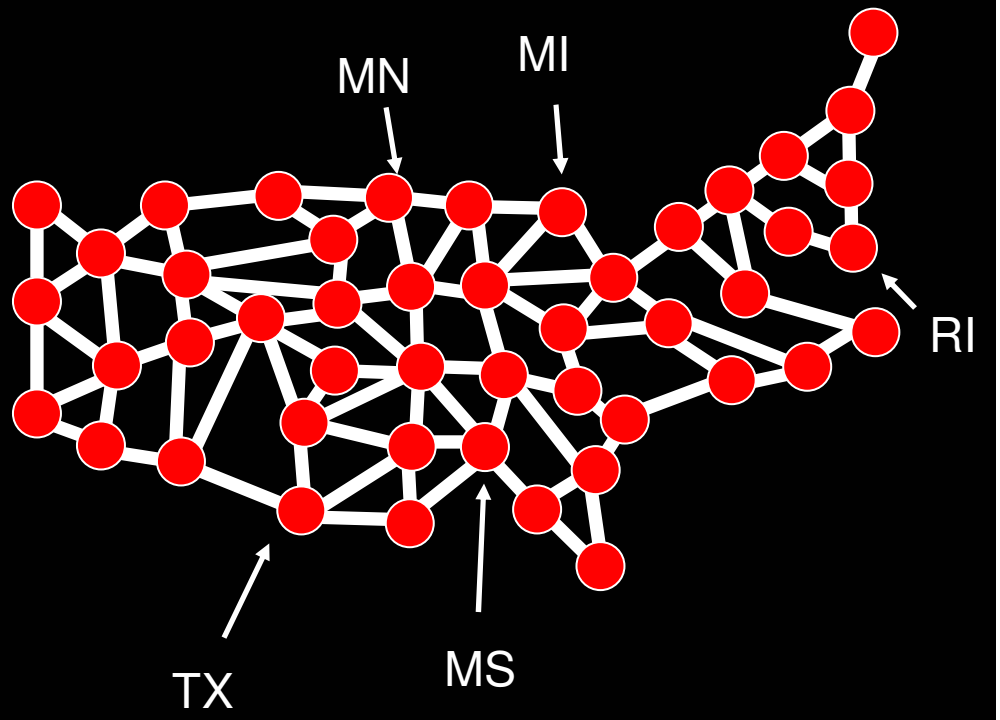
Standard SIR model



S: susceptible
E: exposed but not yet infectious
I: infectious
R: recovered

Composible Graphs





Eclipse Open Healthcare Framework

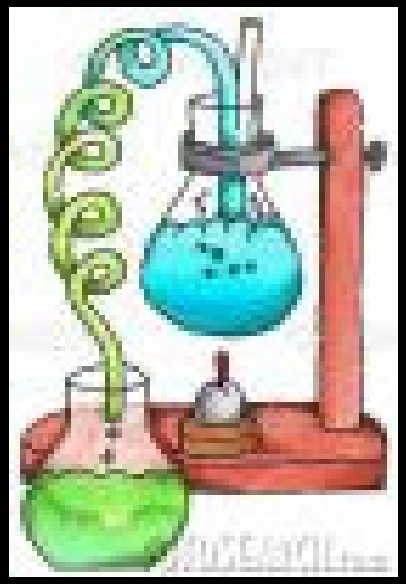
May 22, 2006

STEM is the first application of the public health component

http://www.eclipse.org/ohf

STEM as an experiment

- Hypothesis:
  - “Open-source development techniques are powerful enough to create information technology that can mount an effective response to a pandemic."



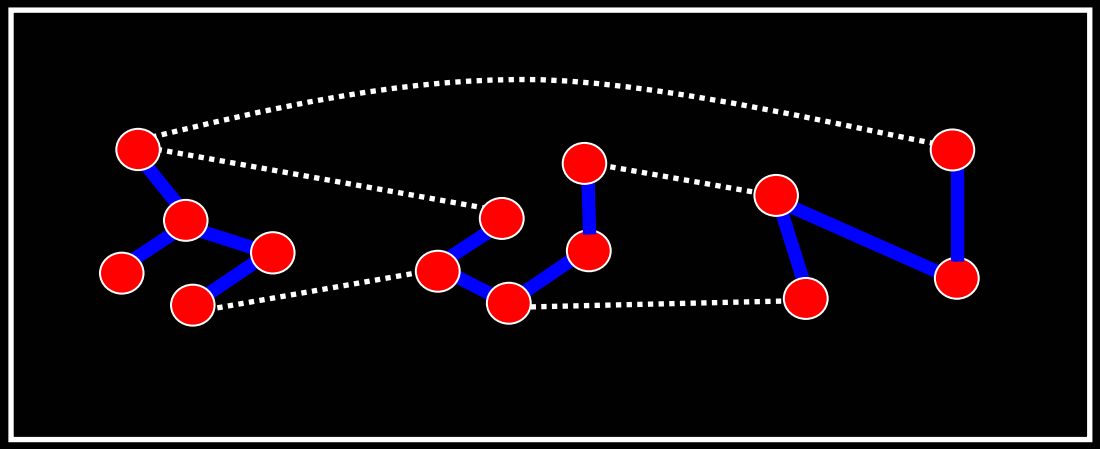
Thoughts

IBM's global perspective, global resources, research capabilities, IT "smarts", and neutral position, make it the only organization capable of starting the development of a global tool for infectious disease modeling.

IBM cannot finish the job.
The world needs a community effort.

STEM 1

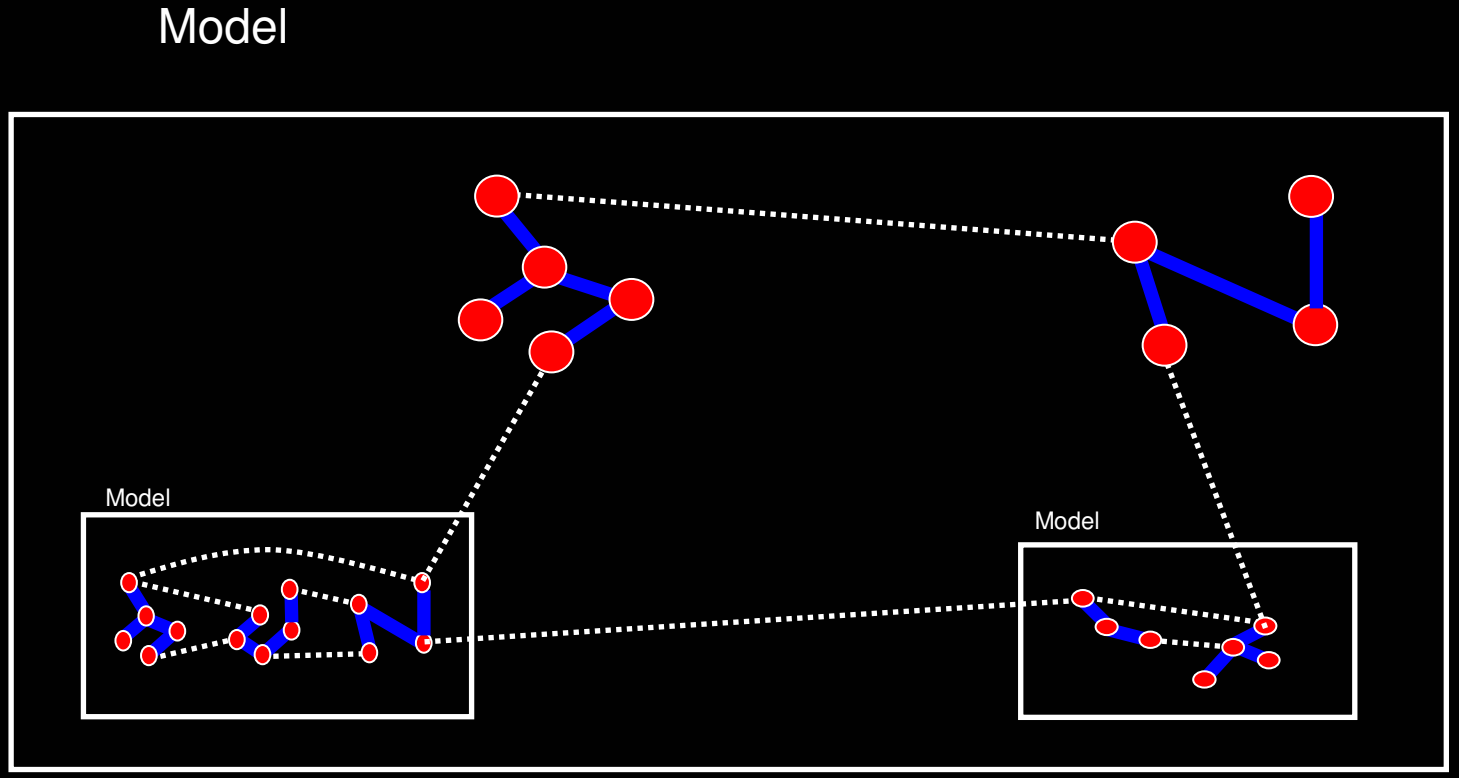
Configuration



- ☑ Multiple SEIR Labels for Nodes
- ☑ Extensible Computation
- ☑ Built-in Models (SIR, SEIR)
- ☑ Triggers
- ☑ Extensive Data

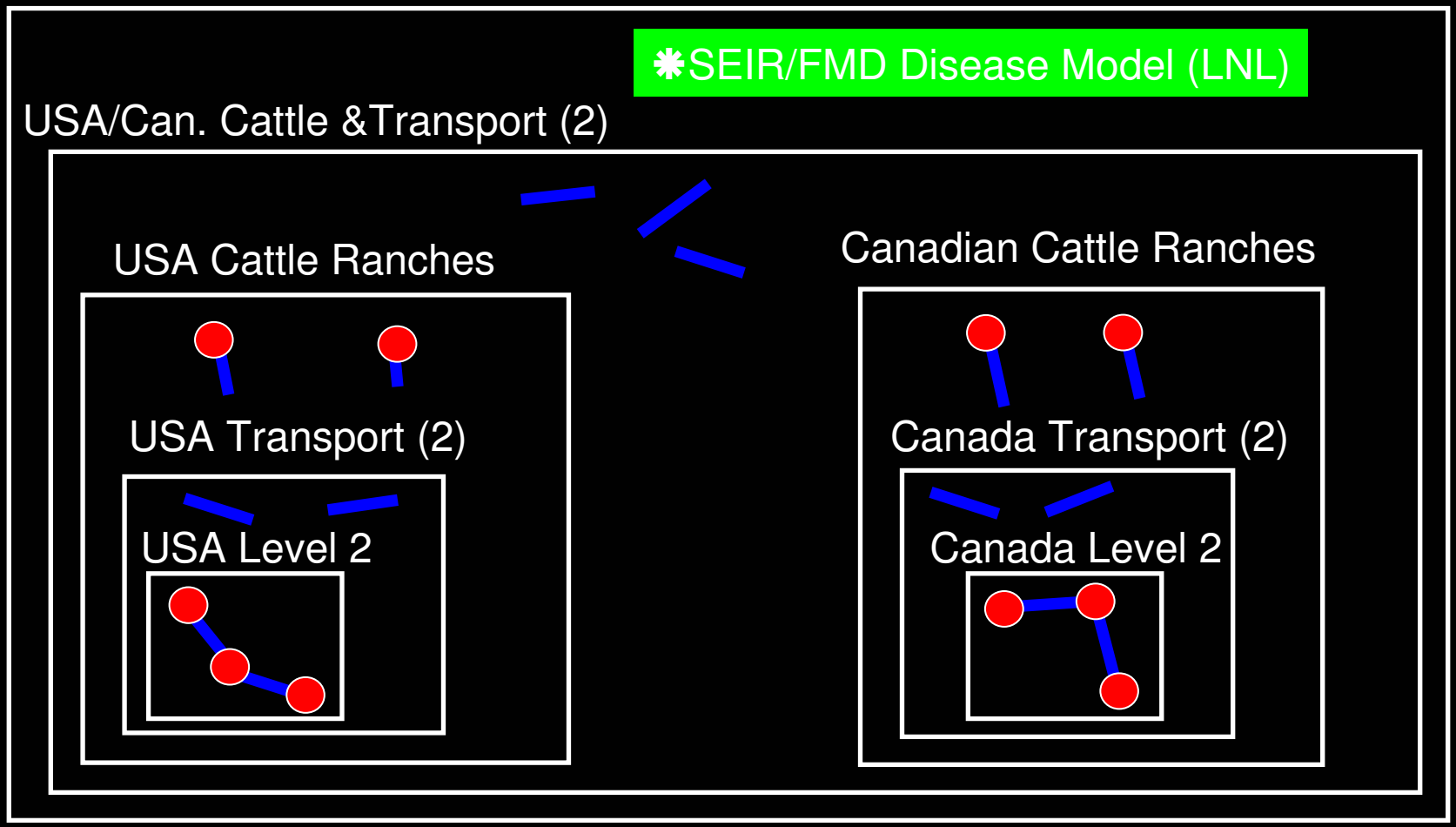
- ☒ Single Layer of Composition
- ☒ Fixed Edge/Label types
- ☒ No Dynamic Edge Labels
- ☒ No Attribution
- ☒ Fixed Initialization
- ☒ Monolithic Code Base

STEM 2



STEM 2 (example)

North America Foot & Mouth Disease (LNL)



STEM 2

- ☑ Multiple User Defined Labels for Nodes & Edges
- ☑ Dynamic Edge Labels
- ☑ Multi-layer Model Composition
- ☑ Attribution (Dublin Core)
- ☑ Extensible Computation
- ☑ Built-in Models (SIR, SEIR)
- ☑ Triggers
- ☑ Extensive Data
- ☑ Common Data Types (Scientific Units, Population, etc.)
- ☑ Multilingual
- ☑ Scenario/Model/Graph can be shared
- ☑ Automatic Scenario/Model/Graph Update
- ☑ Automatic Software Update
- ☑ Windows/Linux/Mac
- ☑ Real-Time “Simulation”
- ☑ Multiple Parallel Simulation Execution/Comparison
- ☑ Standards based
- ☑ Extensible Code base
- ☑ OPEN SOURCE!

Government

Firewall

Web Server

Model

Academia

Web Server

Viewers

Project

Model

Model

Sequencer

Government

Web Server

Viewers

Sequencer

Industry

Summary

- Access to and understanding of data are barriers facing healthcare IT interoperability
- Lowering these barriers will involve
  - Standards based infrastructure
  - Adoption, implementation and maintenance of current standards by healthcare applications
  - Active development community, most likely via open source