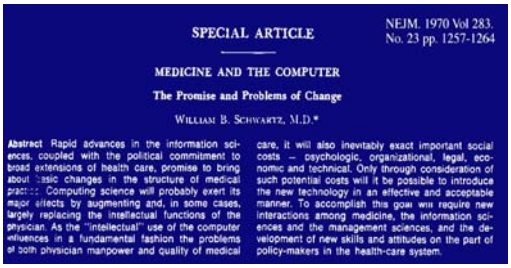
Integrative Informatics

Isaac S. Kohane
4.27.04

Early Vision



SPECIAL ARTICLE

NEJM. 1970 Vol 283. No. 23 pp. 1257-1264

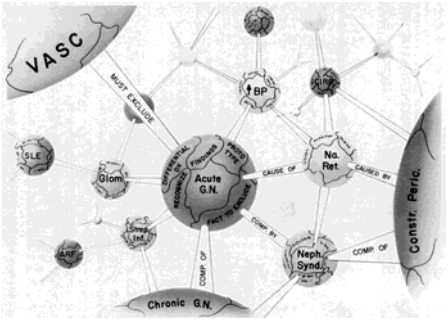
MEDICINE AND THE COMPUTER

The Promise and Problems of Change

WILLIAM B. SCHWARTZ, M.D.*

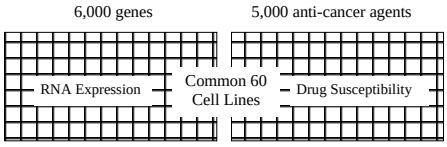
Abstract Rapid advances in the information sciences, coupled with the political commitment to broad extensions of health care, promise to bring about basic changes in the structure of medical practice. Computing science will probably exert its major effects by augmenting and, in some cases, largely replacing the intellectual functions of the physician. As the "intellectual" use of the computer influences in a fundamental fashion the problems of both physician manpower and quality of medical care, it will also inevitably exact important social costs – psychologic, organizational, legal, economic and technical. Only through consideration of such potential costs will it be possible to introduce the new technology in an effective and acceptable manner. To accomplish this goal will require new interactions among medicine, the information sciences and the management sciences, and the development of new skills and attitudes on the part of policy-makers in the health-care system.

PIP's Integration



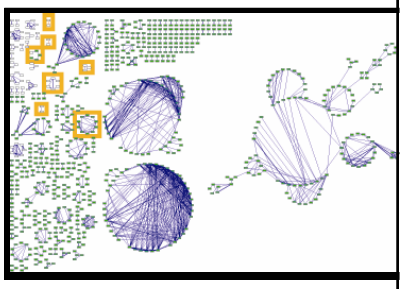
Integrating Genomics and Pharmacology

- RNA expression in NCI 60 cell lines was determined using Affymetrix HU6000 arrays
  - ✓ 5,223 known genes
  - ✓ 1,193 expressed sequence tags
- The RNA expression data set and Anti-cancer susceptibility data set were merged, using the 60 cell lines the two tables had in common

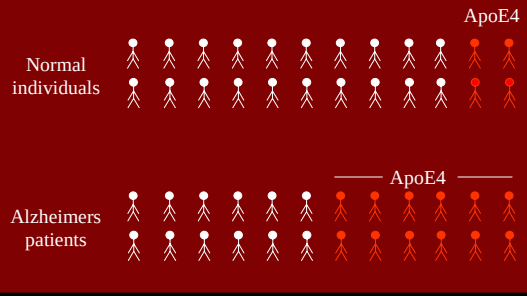


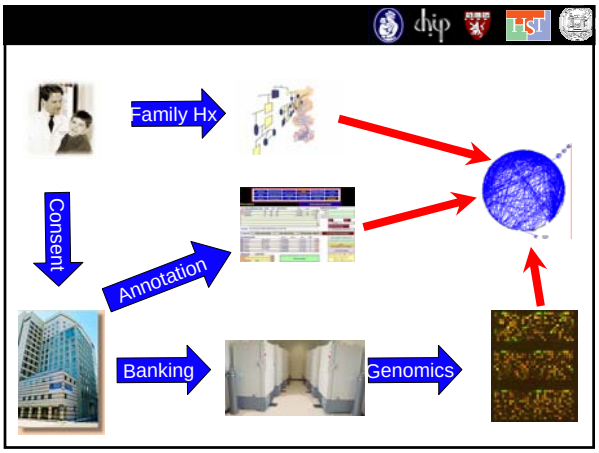
Genes and Anti-Cancer Agents

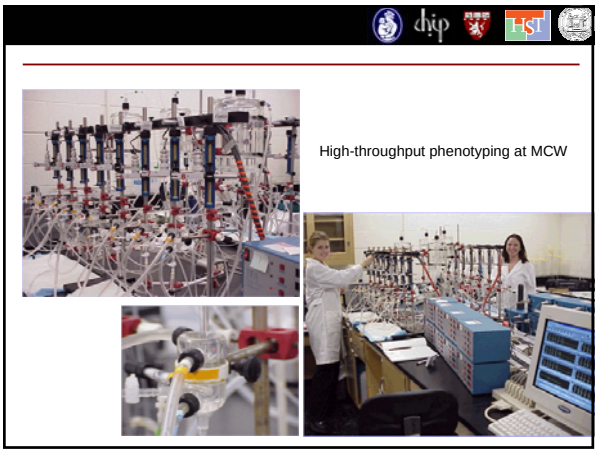
- Threshold r^{2} was 0.8
- 202 networks
- 834 features out of 11,692 (7.1%)
- 1,222 links out of 68,345,586 (.0018%)
- Only one link between a gene and anti-cancer agent



Population Studies Integrates with Genomics







So...

Show Me The Data!

Recurring Themes

- Minimal data model
- Abstraction layers
- Leverage existing data sources

An Institutional View

W3-EMRS: The Problem

- 1993: Sad state-of-the-art
- Within institutions, multiple heterogeneous applications with disparate databases.
- Across merged, collaborating institutions, little commonality in function, data model, or user interface
- Economic realities: increase in large multi-institutional healthcare delivery systems.

Repository/Warehouse

- Building common repositories may not always be the optimal strategy
  - ✓ Time of modelling
  - ✓ Time to implement
  - ✓ Keeping real-time consistency with legacy apps.
  - ✓ Intellectual property
  - ✓ Privacy
  - ✓ Performance (e.g. in ICU)

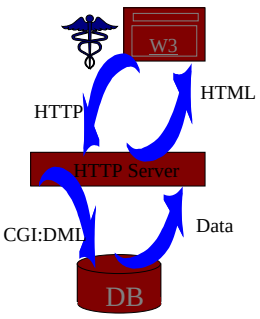
The NLM-Funded W3-EMRS Project

- 1994 NLM RFA
  - ✓ Challenge to design national EMR
- 1994 Implementation
- 1995 Boston EMR Collaborative
  - ✓ Children's, BIH, MGH, MIT

W3-EMRS Solution

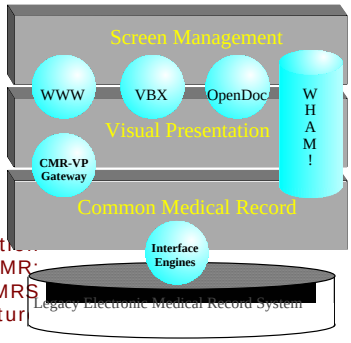
- Understanding that "legacy" systems have long lives
- Understanding of importance of a unifying architecture
- Use of Internet technologies for "lightweight" integration

Standard First-Generation W3-based EMR Design

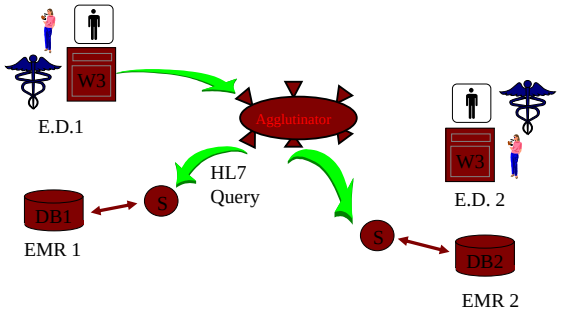


- Single data-model
  - ✓ Often implicit
  - ✓ Difficult to maintain
  - ✓ Unsuitable for unifying multiple heterogeneous systems
- Remote, multi-platform viewing
- Rapid development of view-only function

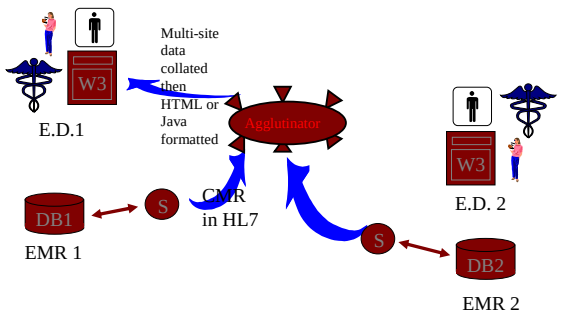
Second Generation Web-based EMR: W3-EMRS Architecture



W3-EMRS: Data Flow for Query



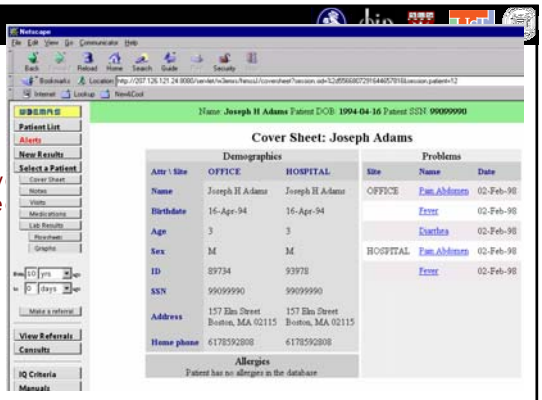
W3-EMR Data Flow for Respon



Early Success with W3-EMRS

- Hyperbilirubinemia project with Children's, BWH, BIH.
- Single institution implementation at Children's.
- 6.872 Final Project by John Halamka --> CareWeb

Cov She

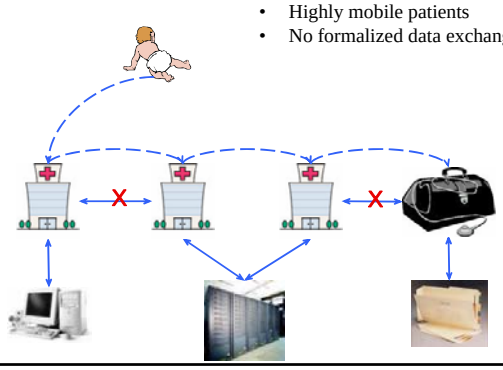


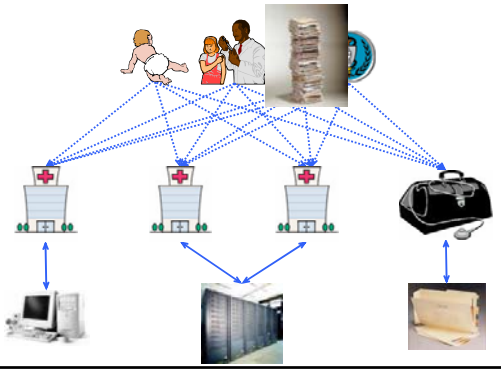
The Patient View

The Problem

- Multiple Causes of Inertia Beyond Technology
- Patients have difficulty accessing their medical information

- Highly mobile patients
- No formalized data exchange

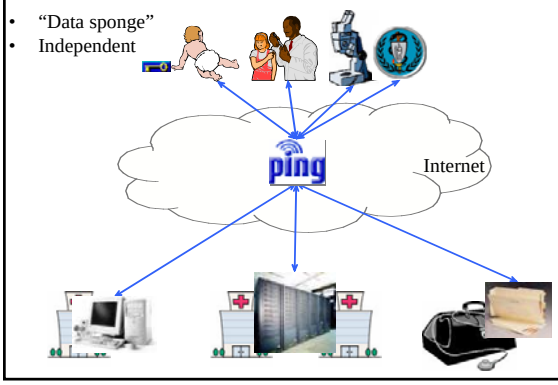


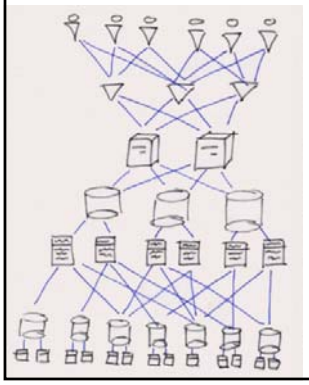


Solution: PING

- Personal Internetworked Notary and Guardian
- Personally controlled records
- Ubiquitous
- Open standards
- Open source
- Web interface
- Public key infrastructure
- XML-based data

- "Data sponge"
- Independent





Actors

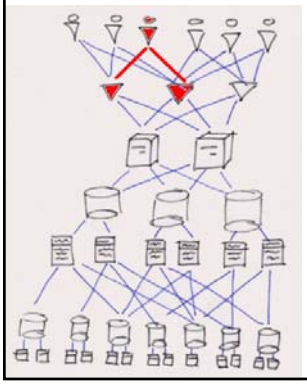
use

Clients
to communicate with

PING Servers
which authenticate and
authorize the access to
PING Storage
which contains

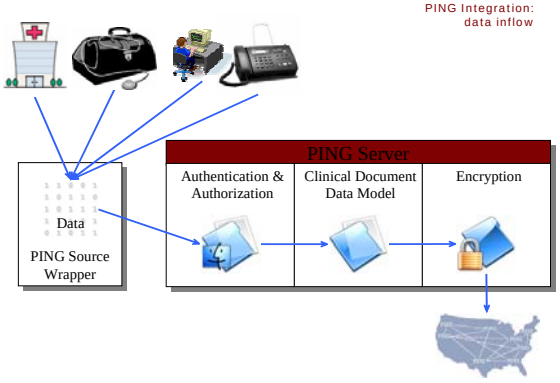
PING Records
which can also contain pointers to

Remote PING Storage
which contains
Remote PING Records



- A patient accesses her medical record with any of a number of clients.
  - ✓ The most basic client is the generic PING record browser
  - ✓ Other types clients may provide
    - decision support
    - laboratory value interpretation
    - data acquisition functions
- A patient may choose to share the record with another *actor* by granting role-based access

PING Integration:
data inflow



PING Example Application

- Regional Immunization Registry
  - ✓ Larger scale services
  - ✓ Wide variety of data
    - ☞ Results
    - ☞ Intervention
    - ☞ Self-reporting
  - ✓ Graphical representation of data
  - ✓ Ability to annotate a record
- New Brunswick and Canada
- PING Response

But Can We Still Better Leverage What is Already Electronic

Consented High-Performance Indexing and Retrieval of Pathology Specimens

CHIRPS

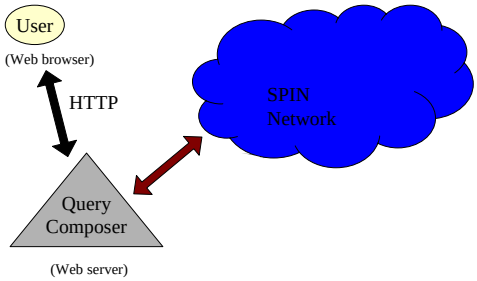
one of 2 Shared Pathology Informatics Networks (SPIN, funded by NCI)

UCLA Medical Center
Harvard Medical Center

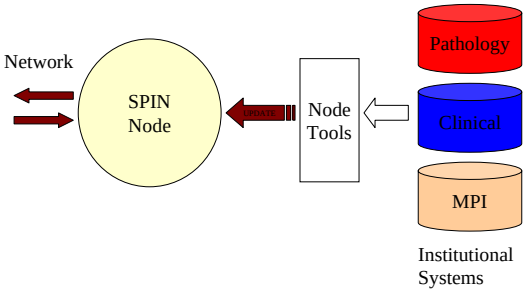
Goals

- Maximize access/finding of resources.
- Minimize disclosure (privacy and IP).
- Decentralized architecture.
- Maximize autonomy.
- Meticulous attention to the heterogeneity of consent.

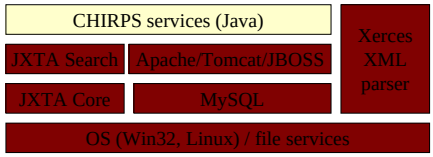
Birds-eye view of SPIN



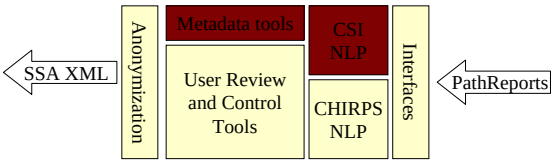
Local view of institution: Loosely Coupled Federation

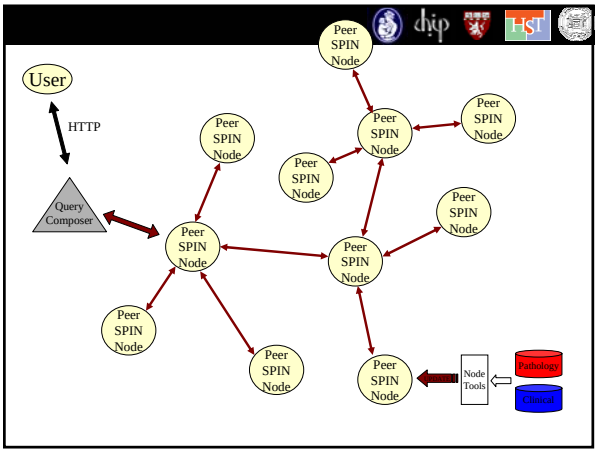


Inside a CHIRPS SPIN node

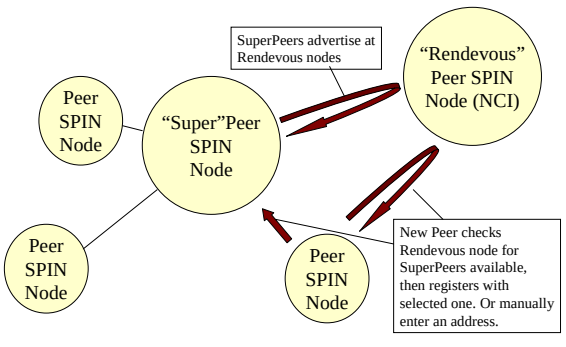


CHIRPS Node Tools

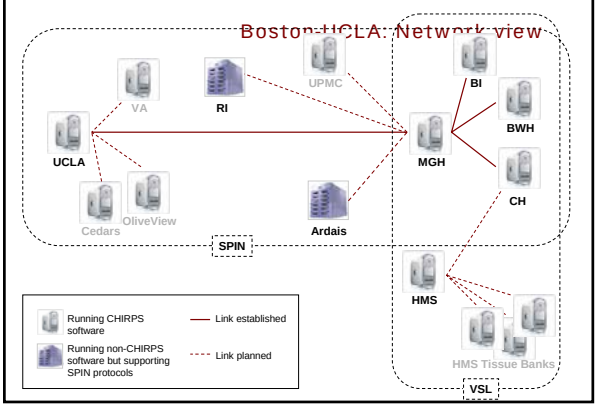




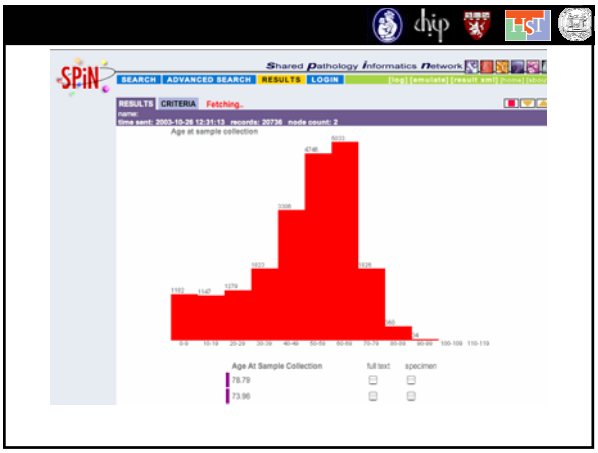
Peer discovery

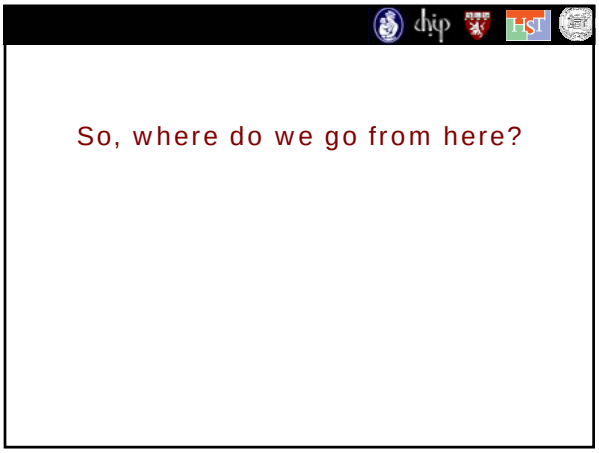


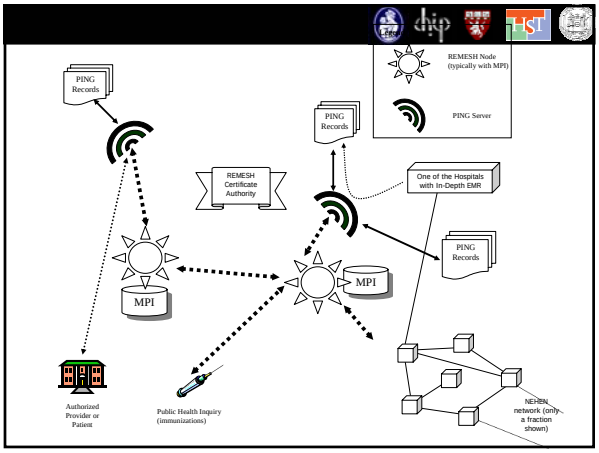
Boston-UCLA Network view

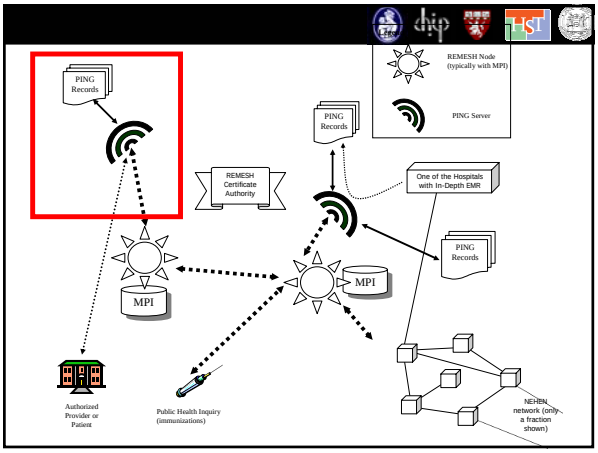



Not Registered? ENTER HERE
REQUEST ACCOUNT
username: demo2
password:
REGISTERED USER LOGIN
SPiN
Shared Pathology Informatics Network
The objective of this initiative is to use state-of-the-art informatics techniques to establish an Internet-based virtual database that will allow investigators to locate appropriate human tissue specimens for their research.
The SPIN software will allow approved researchers access to data that describe archived tissue specimens across multiple institutions while still allowing those institutions to maintain local control of the data. The need for this capability has been fueled by the growing use of tissues, diagnostic specimens, and their related clinical data in modern biomedical research.
SEARCH
diagnosis
renal transplant
gender
Female
age at specimen
BETWEEN
topology


SPiN
Shared Pathology Informatics Network
SEARCH
ADVANCED SEARCH
RESULTS
LOGIN
RESULTS
CRITERIA
Fetching..
Age At Sample Collection
full text
specimen


So, where do we go from here?


PING Records
REMESH Node (typically with MPI)
PING Server
REMESH Certificate Authority
One of the Hospitals with In-Depth EMR
MPI
Authorized Provider or Patient
Public Health Inquiry (immunizations)
NEHEN network (only a fraction shown)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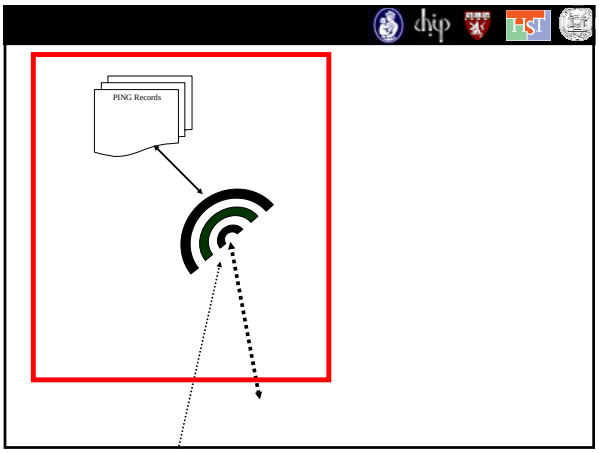
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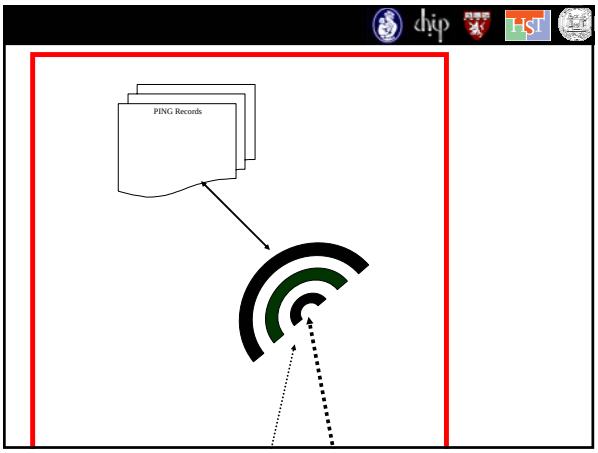
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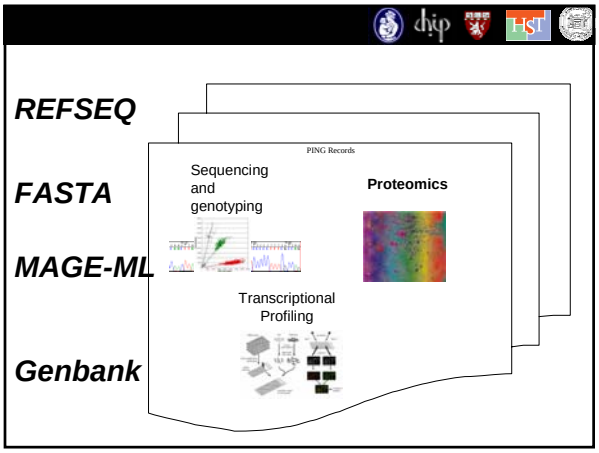
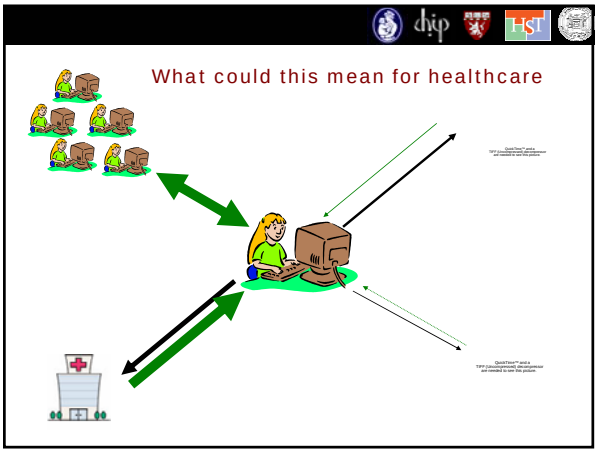
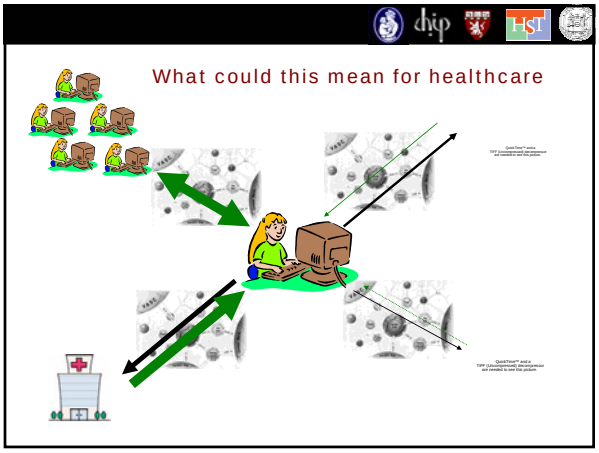

REFSEQ
FASTA
MAGE-ML
Genbank
PING Records
Sequencing and genotyping
Proteomics
Transcriptional Profiling


What could this mean for healthcare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