caBIG® Innovation Platform: New Generation of Biomedicine

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National Cancer Institute

caBIG | 2009 ANNUAL MEETING

21st Century Biomedicine and the Knowledge Economy

- **Quality care is delivered through ready access to care guidelines and practice plans accessible through decision support systems**

  Quality

- **Knowledge bases support ongoing assessment of effective interventions informed by individual characteristics including molecular information**

  Comparative Effectiveness

- **Access to electronic health information at point of care permits ongoing assessment of safety of approved interventions in real world settings**

  Pharmaco-Vigilance

- **Biomedical research effectively leverages health observations and rapidly feeds back approved interventions into a care setting**

  Biomedical Research

Knowledge Worker Ecosystem

Consumers — Personal Health Records

Healthcare Providers — Medical Records

Community Hospitals — Hospital Records

Research Institutions — Clinical Trial Information

Commercial Innovators — Drug and Diagnostic Information

Food and Drug Administration — Approval and Safety Information

NIH — Research Results

Medicaid and Medicare — Reimbursement Information

20th Century Research Biomedical Paradigm
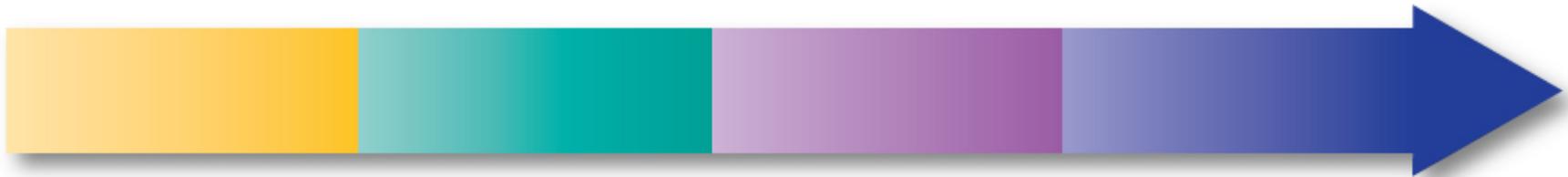
Discovery

- Biological pathways
- Target identification and validation

Product Development

- Candidate selection and Optimization
- Pre-clinical testing
- Phase I, II, III
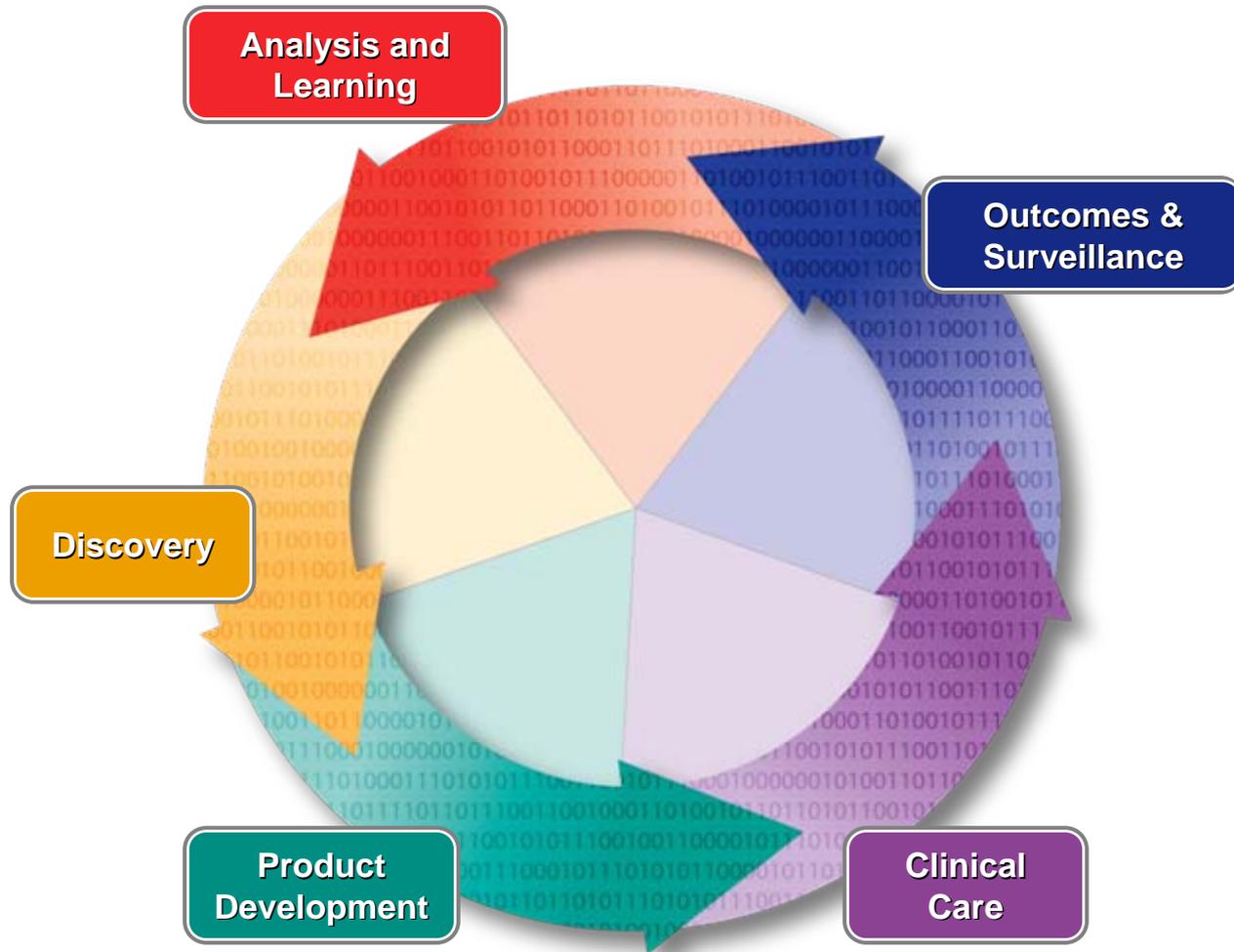- New Drug application and Approval

Clinical Care

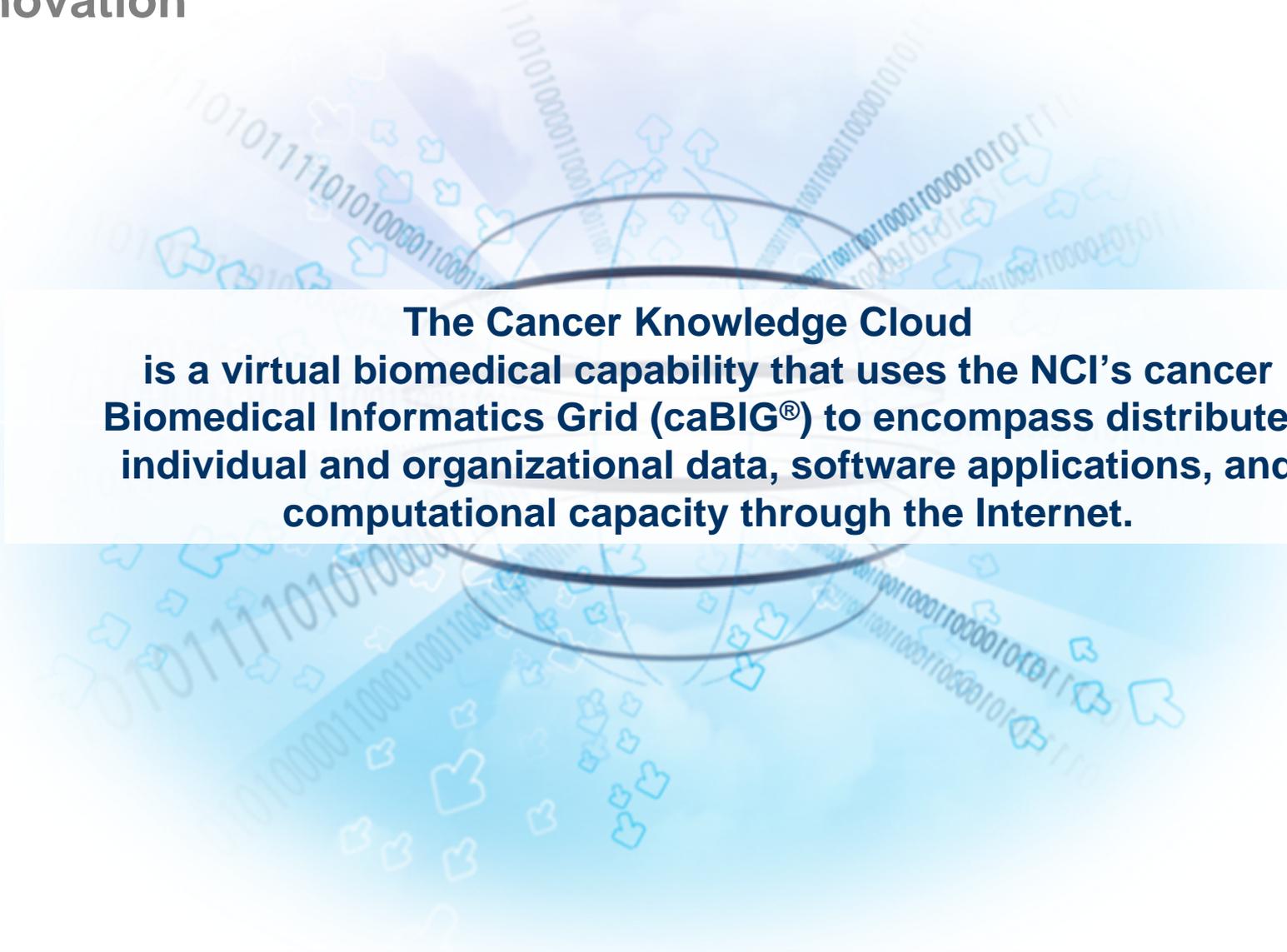- Product launch
- Clinical adoption

Outcomes & Surveillance

- Reporting of serious/fatal ADRs
- Re-labeling (or recall) as needed
- Additional indications as warranted

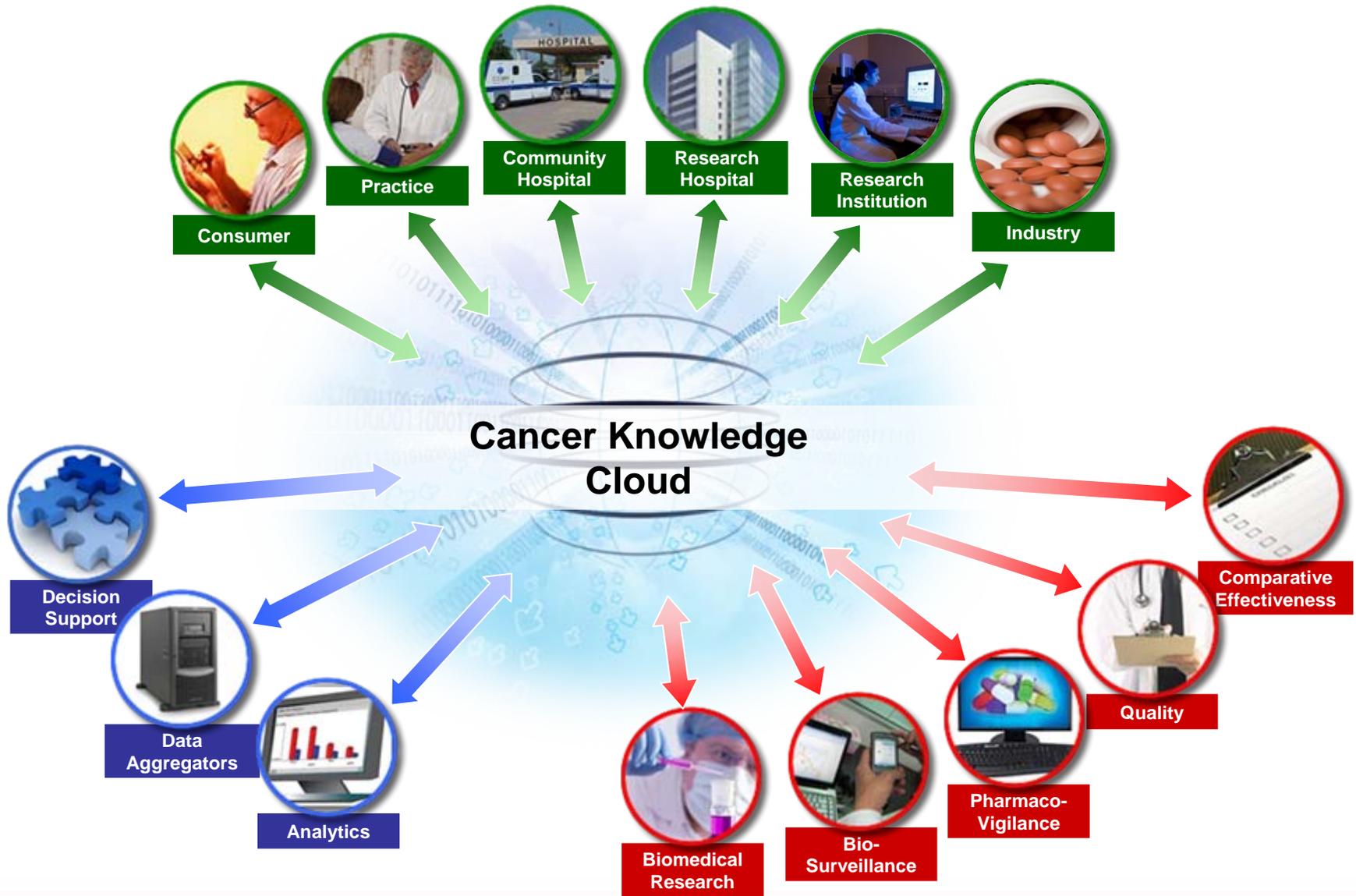# 21th Century Research Biomedical Paradigm: a Learning Health System

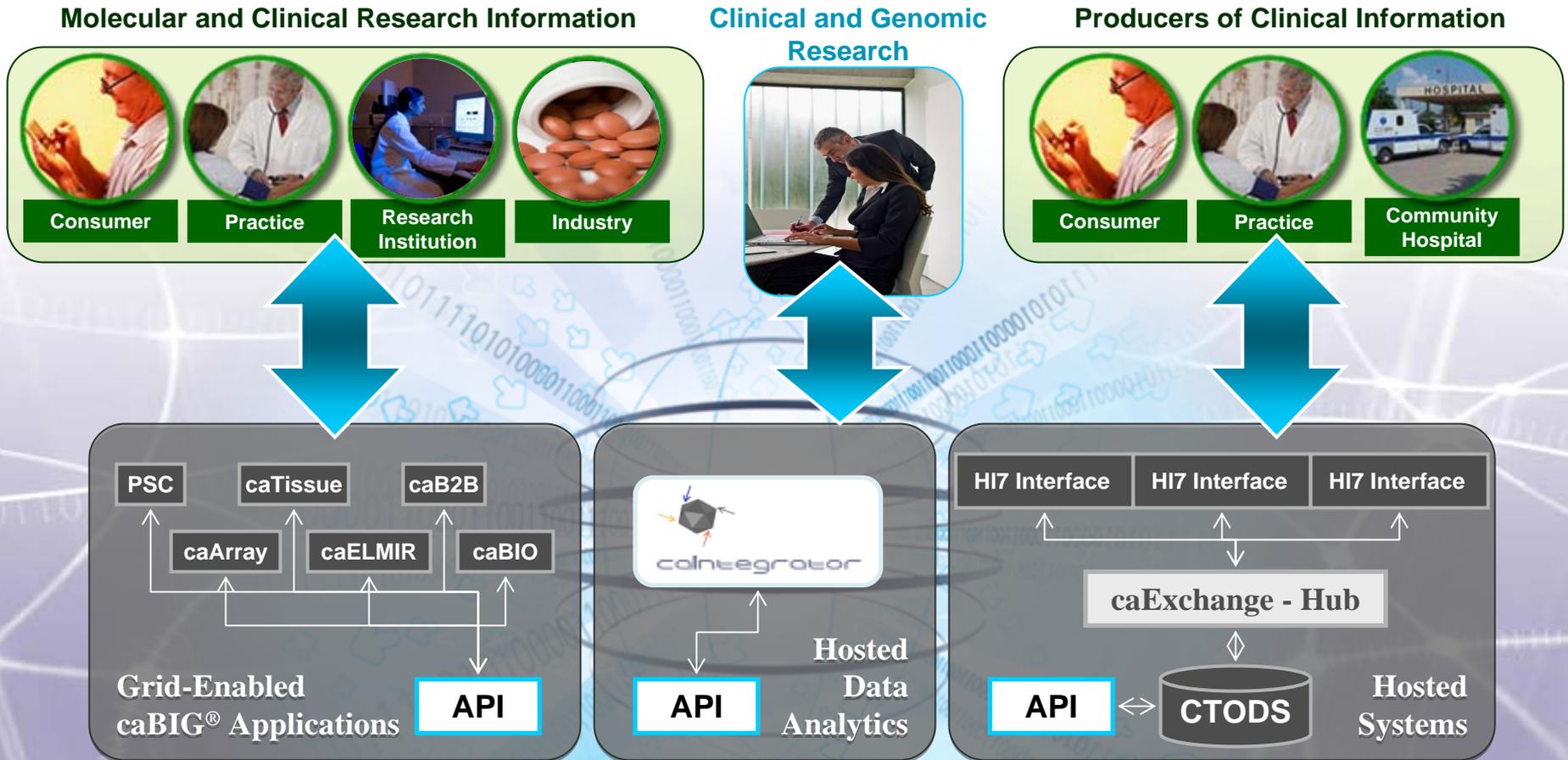# "Cancer Knowledge Cloud": A Platform for Biomedical Innovation

The Cancer Knowledge Cloud
is a virtual biomedical capability that uses the NCI's cancer Biomedical Informatics Grid (caBIG®) to encompass distributed individual and organizational data, software applications, and computational capacity through the Internet.

"Cancer Knowledge Cloud"

Consumer

Practice

Community Hospital

Research Hospital

Research Institution

Industry

Cancer Knowledge Cloud

Decision Support

Data Aggregators

Analytics

Biomedical Research

Bio-Surveillance

Pharmaco-Vigilance

Quality

Comparative Effectiveness

caBIG® Underpins The Cancer Knowledge Cloud

Molecular and Clinical Research Information

| Consumer | Practice | Research Institution | Industry |

Clinical and Genomic Research

Producers of Clinical Information

| Consumer | Practice | Community Hospital |

Grid-Enabled caBIG® Applications

PSC | caTissue | caB2B

caArray | caELMIR | caBIO

API

caIntegrator

Hosted Data Analytics

API

Hl7 Interface | Hl7 Interface | Hl7 Interface

caExchange - Hub

API ⟷ **CTODS**

Hosted Systems

caGRID

caBIG® Capabilities Are Relevant to Discovery, Clinical Research, and Clinical Care

Clinical Research

- Track clinical trial registrations
- Facilitate automatic capture of clinical laboratory data
- Manage reports describing adverse events during clinical trials

Imaging

- Use NBIA repository for medical images including CAT scans and MRIs
- Visualize images using DICOM-compliant tools
- Annotated Images with distributed tools

Clinical Care

Discovery Research

- Combine proteomics, gene expression, and other basic research data
- Submit and annotate microarray data
- Integrate microarray data from multiple manufacturers and permit analysis and visualization of data

Pathology

- Access library of well characterized and clinically annotated biospecimens
- Use tools to keep an inventory of a user's own samples
- Track storage, distribution, and quality assurance of specimens

caBIG® as a Platform for a Biomedical "App Store"
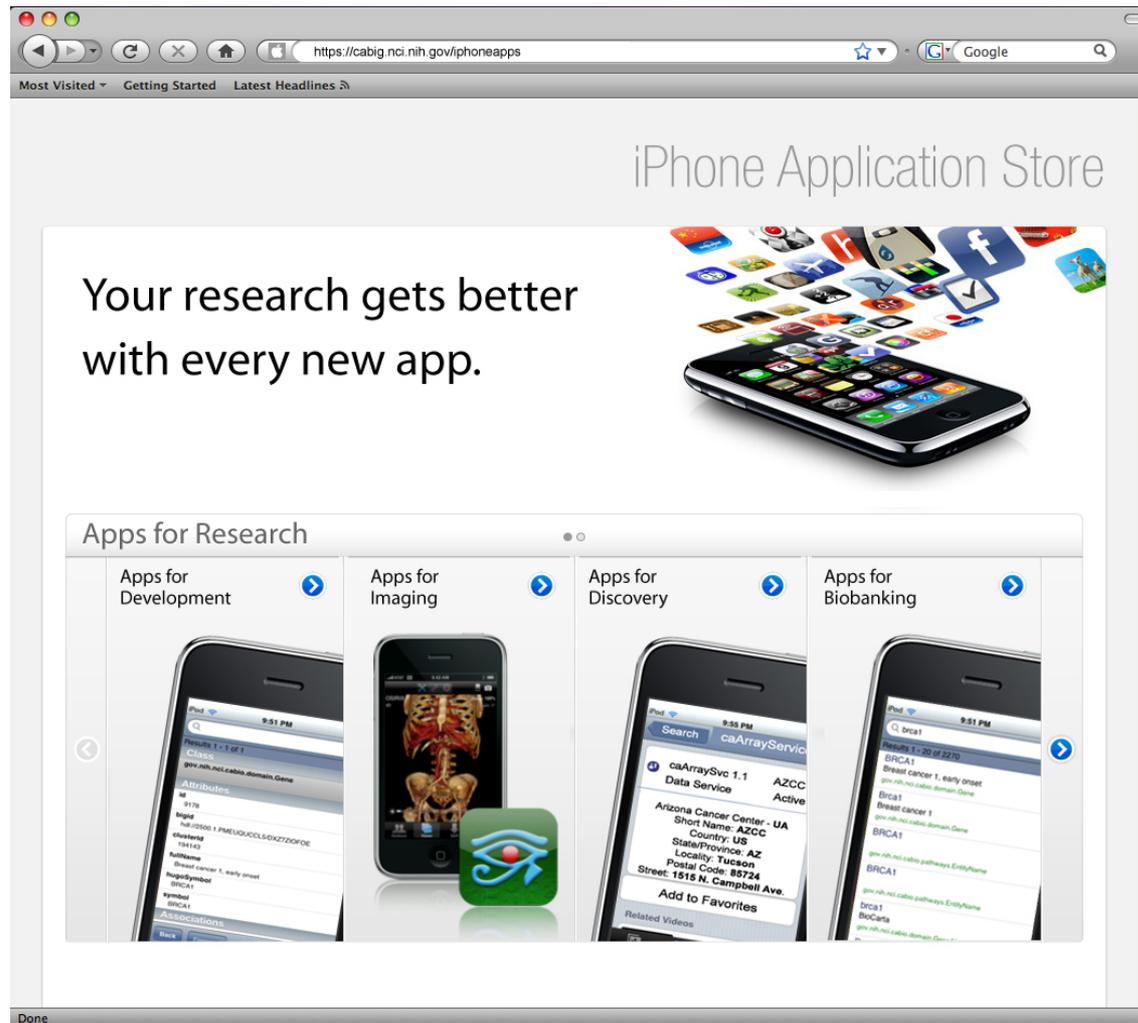
Biomedical Information (caBIO) | Medical Imaging (OsiriX) | Biomedical Services (caGrid) | Biospecimens (caTissue)

caBIG® In The Cloud…
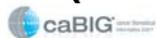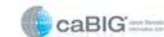
Using caBIG® to Classify Lymphoma

- **Scientific value**
  - Use gene-expression patterns associated with two lymphoma types to predict the type of an unknown sample.
  - Connect caGrid data service (caArray) with analytical services (PreProcess, SVM and KNN from GenePattern).

- **Major steps**
  - Querying training data from experiments stored in caArray.
  - Preprocessing, i.e., normalizing the microarray data.
  - **Predicting lymphoma type** using SVM & KNN services.

- **Extension**
  - Generalized the workflow into a cancer type prediction routine that can be used on other caArray data sets.
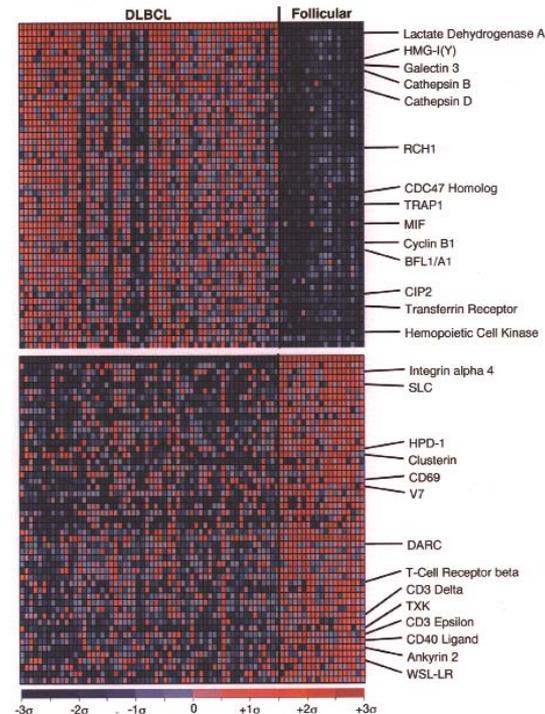
Ravi Madduri
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U. Manchester, UK

Wei Tan
Univ. Chicago

Dinanath Sulakhe
Univ. Chicago

Stian Soiland-Reyes
U Manchester, UK

*Fig. from MA Shipp. Nature Medicine, 2002

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Lymphoma Prediction Workflow

MicroArray from

tumor tissue
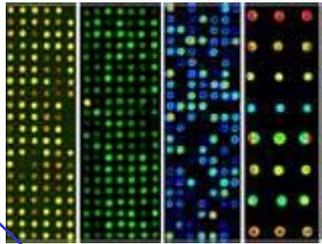
Microarray

preProcessing
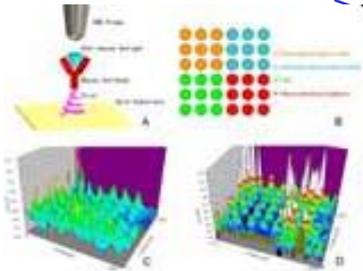
Lymphoma

classification

Ack. Juli Klemm, Xiaopeng Bian, Rashmi Srinivasa (**NCI**)
Jared Nedzel (**MIT**)

A New Model for Biomedicine

caBIG™ | 2009 Annual Meeting

Using the Knowledge Cloud…

Research

Participants

Patients join research networks, grant consent, agree to be "sought" and to enroll – "on-demand" participants

Biospecimen Collections

Researchers can access and query large collections of well-characterized, clinically annotated specimens

Discovery of Correlations

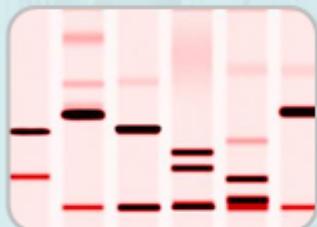Biomarkers are identified and validated; disease sub-groups emerge

Individualization of Treatment

Patients are identified by sub-groups and treated appropriately

BCM
Baylor College of Medicine

Using the Knowledge Cloud…

Consumer

My Genomic Profile
Consumers get their genetic and predisposition risk information

My Prevention Strategies
Consumers work with genetic counselors; coordinate with health care provider

My Clinical Record
Consumers link to their clinical histories with genetic profiles; access clinical research; participate in volunteer networks

Using the Knowledge Cloud…

Clinical Practice

Electronic Health Records
EHRs can connect to clinical trials in hospital settings

Research Finding Knowledgebases
Large-scale databases of latest research findings are connected to health delivery encounter

Learning Healthcare System
Local and national clinical encounter information is fed back to care providers to help inform clinical decision making
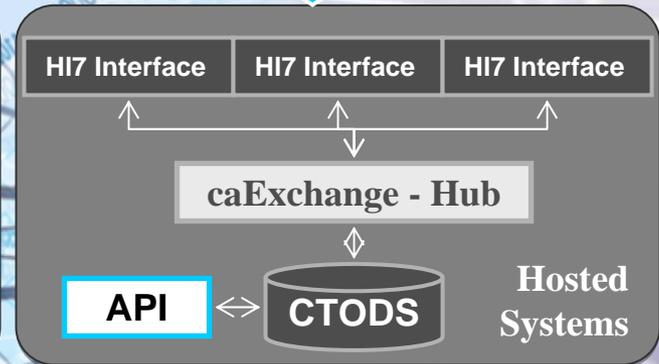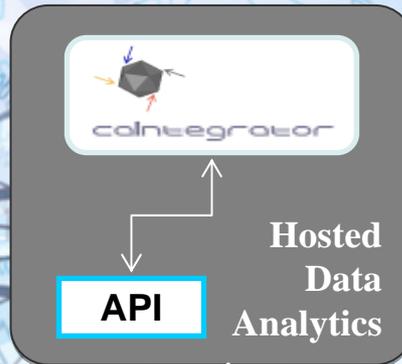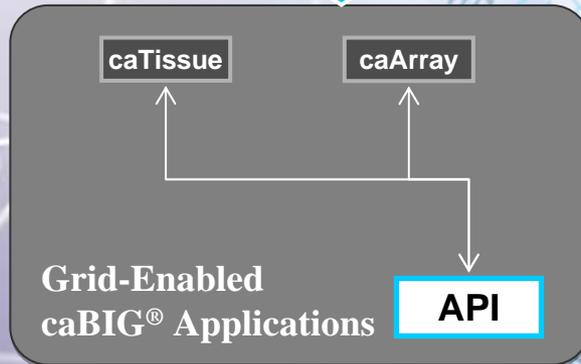
caBIG® Enables Comparative Effectiveness Research

Molecular and Clinical Research Information

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Practice

Research Institution

Producers of Clinical Information

Consumer

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Community Hospital

caTissue	caArray

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Hosted Data Analytics

Hl7 Interface	Hl7 Interface	Hl7 Interface

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Comparative Effectiveness Research

caGRID

Our Distinguished Panel

- **Aneesh Chopra, M.P.P.**
  United States Chief Technology Officer

- **Stephen Friend, M.D., Ph.D.**
  President & CEO
  Sage

- **Greg Simon, J.D.**
  Senior Vice President, Worldwide Policy
  Pfizer