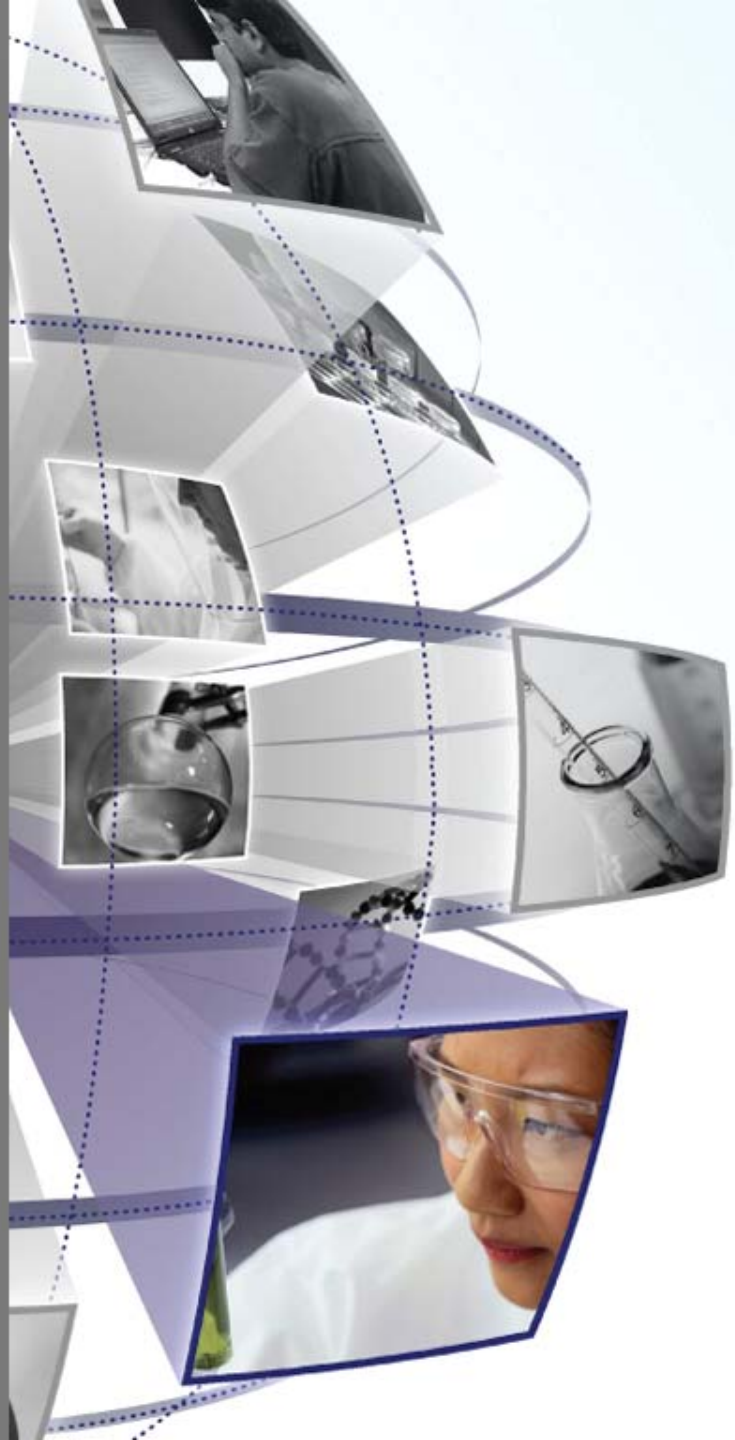
National Cancer Institute



caBIG®
cancer Biomedical Informatics Grid™

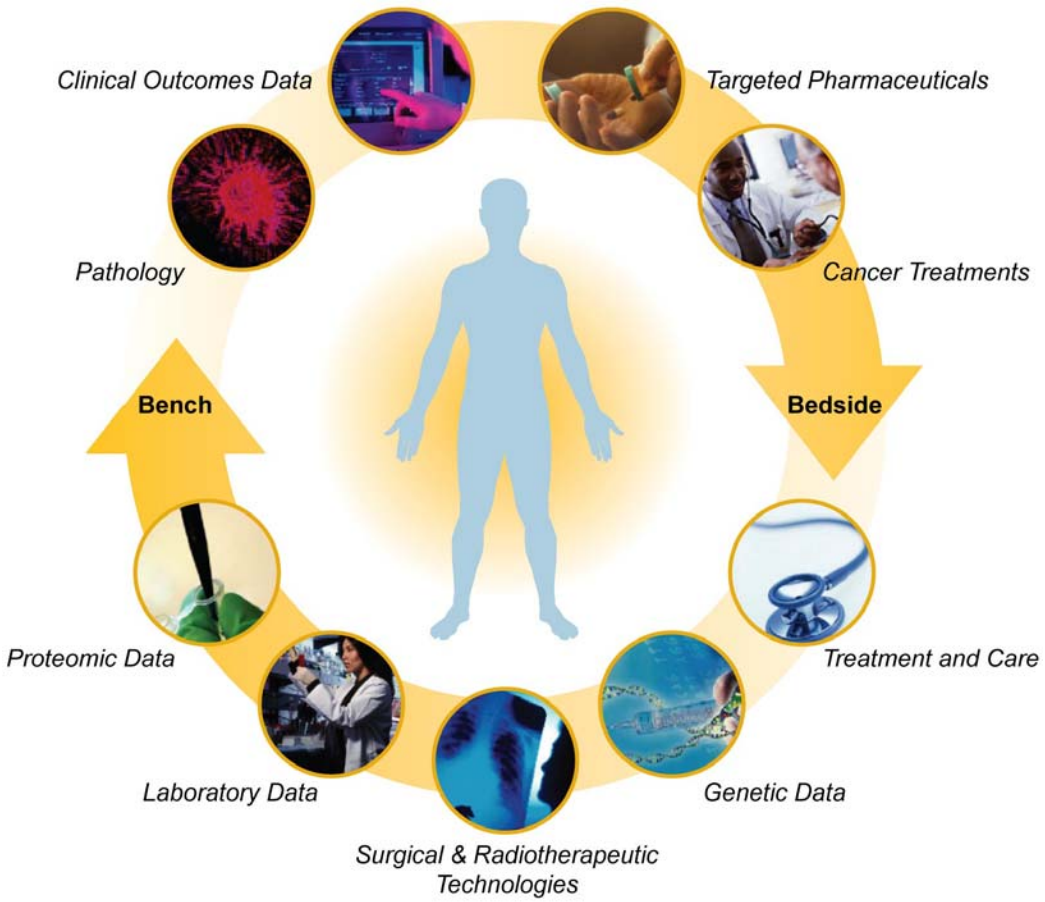
NCI Enterprise Services to Support Research and Care

George Komatsoulis, Ph.D.
Deputy Director
National Cancer Institute
Center for Biomedical Informatics and Information Technology

“If You Don't Know Where You're Going, Any Road Will Get You There.”

-**Lewis Carroll:** *Alice’s Adventures in Wonderland*, 1865

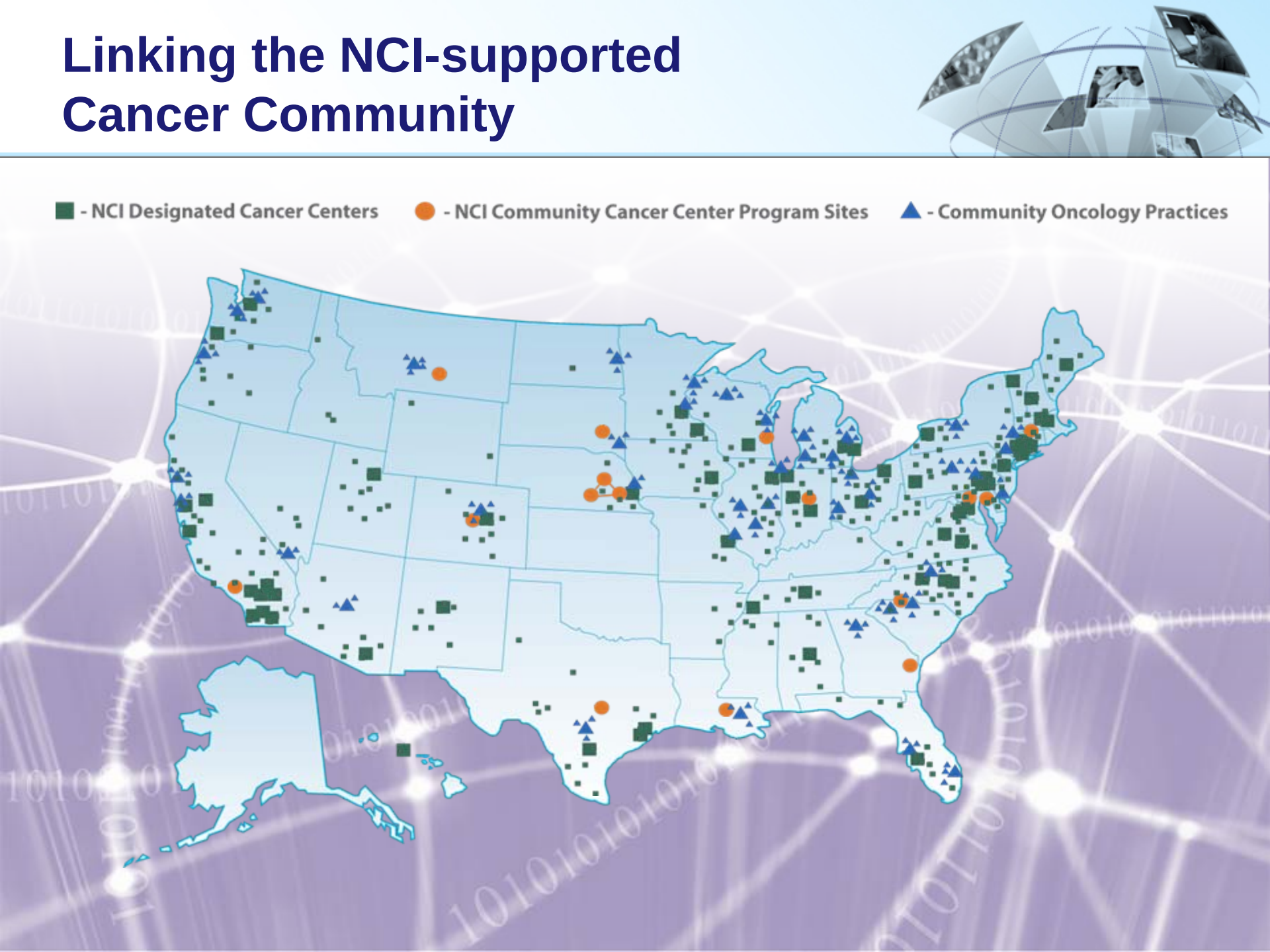
21st Century Biomedicine



- **Personalized, Predictive, Preemptive, Participatory…**
- **Unifies** discovery, clinical research, and clinical care (bench-bedside-bench) into a seamless continuum - a Learning Health System
- **Results in** improved clinical outcomes
- **Accelerates** the time from discovery to patient benefit
- **Enables** a health care system, not a disparate “sector”
- **Empowers** consumers in managing their health over a lifetime

caBIG cancer Biomedical Informatics Grid™

Linking the NCI-supported Cancer Community



Oncology-Extended Electronic Health Record: A Collaborative National Effort

- **American Society of Clinical Oncologists (ASCO)**
  - Began evaluating issue, involving end users
  - Engaged the vendor community EHR lab (30), utilizing unique case scenarios
  - High level requirements document/white paper outlining the issue
- **cancer Biomedical Informatics Grid (caBIG®)**
  - Vendor technology evaluation
  - Problem assessment
  - Technical Specification
- **NCI Community Cancer Center Program (NCCCP)**
  - Oncology EHR Laboratory
- **Other domain experts**

Semantically-aware Services Oriented Architecture

- Semantically-aware Service Oriented Architecture (sSOA) supports the challenges of integrating diverse classes of information distributed across a distributed, heterogeneous cancer research and care community
- In addition to data integration, sSOA enables the coordination of functionality between the various information systems that reside within those organizations and enable collaborative data processing and work flow execution
- Services can be implemented in a largely standalone fashion to allow for the rapid creation of composite applications via service marshalling or integrated with existing applications

sSOA ensures working interoperability between differing systems that need to exchange specific classes of information and/or coordinate cross-application behaviors

Classes of Services

- **NCI Services are classified into four primary types loosely based on the CBDI service taxonomy**
- **Infrastructure/Utility**
  - Services that are required or utilized by virtually all other services
- **Core**
  - Services that provide information components to capability and business services
- **Business Capability**
  - Services that provide “business atoms”, the data most business processes utilize
- **Business/Process**
  - Arbitrarily complex services that utilize the other three service types to carry out business functions

Periodic Table of Services

"CAPABILITY"/"BUSINESS"

R Registration	**Pt** Protocol	**Oc** Study Outcomes	**Po** Patient Outcomes	**E** Eligibility	**Ae** Adverse Event	**Hx** Hx and Physical	**Dx** Discharge Note	**Ds** Decision Support	**Ra** Referral and Authorization

	Cr Credentialing		**S** Specimen		**Tp** Treatment Plan	**I** Image	**L** Lab	**Rx** Pharmacy	**Sc** Scheduling

"CORE"

Sd SDTM	**Qr** Data Query	**C** Correlation	**O** Organization	**P** Person	**Pa** Protocol Abstraction	**D** Disease	**A** Agent	**Mp** Master Problem List	**Ay** Allergy

"Infra / UTILITY"

Km Knowledge Management	**Cm** Contract Management	**Ev** Enterprise Vocabulary	**Va** Validation	**Tx** Translation	**Au** Audit	**Id** Id Management	**Tr** Trust Management	**Aa** Authorization Authentication	**Py** Policy

caBIG cancer Biomedical Informatics Grid™

Periodic Table of Services: Business/Process

"CAPABILITY" "BUSINESS"

R	Pt	Oc	Po	E	Ae	Hx	Dx	Ds	Ra
Registration	Protocol	Study Outcomes	Patient Outcomes	Eligibility	Adverse Event	Hx and Physical	Discharge Note	Decision Support	Referral and Authorization

The Trial Registration service provides investigators with the ability to submit descriptive information about a clinical trial. It also provides the ability to search registered trials based on various criteria

The Protocol Management service will support creation of a Study Protocol by providing a capability to create a computable part of the protocol

Cr	S	Tp	I	L	Rx	Sc
Credentialing	Specimen	Treatment Plan	Image	Lab	Pharmacy	Scheduling

Study Outcomes establishes a set of reporting patterns for collecting data and validating it in order to report on a particular intervention outcome

"CORE"

Sd	Qr	C	O	P	Pa	D	A	Mp	Ay
SDTM	Data Query	Correlation	Organization	Person	Protocol Abstraction	Disease	Agent	Master Problem List	Allergy

Patient Outcomes provides clinicians or administrators at clinicians' offices with the ability to submit outcome data for the cancer patients. It also provides them with the ability to query the outcomes data they submitted

"Infra / UTILITY"

Km	Cm	Ev	Va	Tx	Au	Id	Tr	Aa	Py
Knowledge Management	Contract Management	Enterprise Vocabulary	Validation	Translation	Audit	Id Management	Trust Management	Authorization Authentication	Policy

Eligibility service provides the capabilities associated with establishing eligibility for a patient to register on a Study based on criteria specified in the Study Protocol

caBIG cancer Biomedical Informatics Grid™

Periodic Table of Services: Business/Process

The Adverse Event service manages, queries, reports adverse events and the associated work flows

"CAPABILITY""BUSINESS"

R	Pt	Oc	Po	E	Ae	Hx	Dx	Ds	Ra
Registration	Protocol	Study Outcomes	Patient Outcomes	Eligibility	Adverse Event	Hx and Physical	Discharge Note	Decision Support	Referral and Authorization

The History and Physical service provides access to patient's History and Physical document. This service will facilitate requests for and provision documents that capture the clinical history of the patient during a specific encounter

Cr	S	Tp	I	L	Rx	Sc
Credentialing	Specimen	Treatment Plan	Image	Lab	Pharmacy	Scheduling

Provides access to a patient's Discharge Notes for a given encounter300

"CORE"

Sd	Qr	C	O	P	Pa	D	A	Mp	Ay
SDTM	Data Query	Correlation	Organization	Person	Protocol Abstraction	Disease	Agent	Master Problem List	Allergy

This service provides an algorithmically-neutral way to manage decision support services for patients

"Infra / UTILITY"

Km	Cm	Ev	Va	Tx	Au	Id	Tr	Aa	Py
Knowledge Management	Contract Management	Enterprise Vocabulary	Validation	Translation	Audit	Id Management	Trust Management	Authorization Authentication	Policy

Referral is intended to provide core capabilities needed by health care organizations to facilitate the business process of patient referrals and consultations among providers

caBIG cancer Biomedical Informatics Grid™

Periodic Table of Services: Business Capability Services

Credentialing Management allows the credentials of a given investigator to be enumerated and validated by a trusted third party

Specimen Management Service provides the core specification for specimen management from both the clinical and research perspectives regardless of the nature of specimen transactions that occur or the type of specimen

The Treatment Plan service provides the ability to create and update Treatment Plan templates, generate and view prospective calendars of patient activities, track activities as they occur, and manage patient calendars as they change during a plan

Image Management service includes the ability to manage image, including intersections with order reporting.

Lab Management service includes the ability to order, track, and manage laboratory orders from a clinical perspective, including intersections with specimen management and pathology reporting

Pharmacy Management service includes the ability to order, track, and manage prescriptions from a clinical perspective

The Scheduling service provides the capabilities associated with scheduling a particular appointment for a particular encounter

"CAPABILITY"/"BUSINESS"

R Registration
Pt Protocol
Oc Study Outcomes
Po Patient Outcomes
E Eligibility
Ae Adverse Event
Hx Hx and Physical
Dx Discharge Note
Ds Decision Support
Ra Referral and Authorization
Cr Credentialing
S Specimen
Tp Treatment Plan
I Image
L Lab
Rx Pharmacy
Sc Scheduling

"CORE"

Sd SDTM
Qr Data Query
C Correlation
O Organization
P Person
Pa Protocol Abstraction
D Disease
A Agent
Mp Master Problem List
Ay Allergy

"Infra / UTILITY"

Km Knowledge Management
Cm Contract Management
Ev Enterprise Vocabulary
Va Validation
Tx Translation
Au Audit
Id Id Management
Tr Trust Management
Aa Authorization Authentication
Py Policy

caBIG cancer Biomedical Informatics Grid™

Periodic Table of Services: Core Services

"CAPABILITY""BUSINESS"

Correlation Service establishes a central service of record for relationships between core information components (Persons to Organizations, etc.)

R Registration

Pt Protocol

Oc Study Outcomes

Po Patient Outcomes

E Eligibility

Ae Adverse Event

Hx Hx and Physical

Dx Discharge Note

Ds Decision Support

Ra Referral and Authorization

Organization Service establishes a central service of record for the Organization information type

Cr Credentialing

S Specimen

Tp Treatment Plan

I Image

L Lab

Rx Pharmacy

Sc Scheduling

Person Service establishes a central service of record for the Person Information

"CORE"

Sd SDTM

Qr Data Query

C Correlation

O Organization

P Person

Pa Protocol Abstraction

D Disease

A Agent

Mp Master Problem List

Ay Allergy

The Protocol Abstraction Service establishes a central service of record for non-annotated, "flat" information about Protocols and their relation to trials

"Infra / UTILITY"

Km Knowledge Management

Cm Contract Management

Ev Enterprise Vocabulary

Va Validation

Tx Translation

Au Audit

Id Id Management

Tr Trust Management

Aa Authorization Authentication

Py Policy

The Disease service establishes a central service of record for information about various diseases found in trials

The Agent service establishes a central service of record for information about various agents found in trials

caBIG cancer Biomedical Informatics Grid™

Periodic Table of Services: Other Core Services

SDTM Represents a key data structure that is reused in regulatory reporting

Data Query provides a consistent mechanism to query and retrieve information from information systems

Master Problem service establishes a central service of record for the Problems tied to patients

Allergy service establishes a central service of record for the Allergies tied to patients

"CAPABILITY""BUSINESS"

R Registration	**Pt** Protocol	**Oc** Study Outcomes	**Po** Patient Outcomes	**E** Eligibility	**Ae** Adverse Event	**Hx** Hx and Physical	**Dx** Discharge Note	**Ds** Decision Support	**Ra** Referral and Authorization

Cr Credentialing	**S** Specimen	**Tp** Treatment Plan	**I** Image	**L** Lab	**Rx** Pharmacy		**Sc** Scheduling

"CORE"

Sd SDTM	**Qr** Data Query	**C** Correlation	**O** Organization	**P** Person	**Pa** Protocol Abstraction	**D** Disease	**A** Agent	**Mp** Master Problem List	**Ay** Allergy	

"Infra / UTILITY"

Km Knowledge Management	**Cm** Contract Management	**Ev** Enterprise Vocabulary	**Va** Validation	**Tx** Translation	**Au** Audit	**Id** Id Management	**Tr** Trust Management	**Aa** Authorization Authentication	**Py** Policy

caBIG cancer Biomedical Informatics Grid™

Periodic Table of Services: Infrastructure/Utility

Identity Management deals with identities of specific entities of interest to the organization

Trust Management establishes verifiable and explicit relationships between technology endpoints in the deployed architecture

Authorization and Authentication service provides a means of testing an identity against a set of credentials and explicit policy within a deployed architecture

The Policy service exposes elaborated, well-formed policies and rules that manifest the organization's permissions, prohibitions, and obligations

"CAPABILITY"/"BUSINESS"

R Registration	**Pt** Protocol	**Oc** Study Component	**Po** Patient Outcomes	**E** Eligibility	**Ae** Adverse Event	**Hx** Hx and Physical	**Dx** Discharge Note	**Ds** Decision Support	**Ra** Referral and Authorization

Cr Credentialing	**S** Specimen	**Tp** Treatment Plan	**I** Image	**L** Lab	**Rx** Pharmacy	**Sc** Scheduling

"CORE"

Sd SDTM	**Qr** Data Query	**C** Correlation	**O** Organization	**P** Person	**Pa** Protocol Abstraction	**D** Disease	**A** Agent	**Mp** Master Problem List	**Ay** Allergy

"Infra / UTILITY"

Km Knowledge Management	**Cm** Contract Management	**Ev** Enterprise Vocabulary	**Va** Validation	**Tx** Translation	**Au** Audit	**Id** Id Management	**Tr** Trust Management	**Aa** Authorization Authentication	**Py** Policy

Periodic Table of Services: Infrastructure/Utility

Knowledge Management service represents a series of capabilities around the storage, versioning, and expression of the semantics supporting key capabilities

Service Contract Management service represents a series of capabilities around the storage, versioning, and expression of the contract semantics supporting interoperability

Enterprise Vocabulary Services support the management, storage, and mapping of terminologies and value sets

The Validation service verifies structural and semantic consistency across messages used in interoperability scenarios

The Transformation service provides a functional end point to manage and enact mappings between syntactically disparate information types

The Auditing service provides an interface that captures auditing information around the access to sensitive data

"CAPABILITY"/"BUSINESS"

R Registration	Pt Protocol	Oc Study Outcomes	Po Patient Outcomes	E Eligibility	Ae Adverse Event	Hx Hx and Physical	Dx Discharge Note	Ds Decision Support	Ra Referral and Authorization
Cr Credentialing	S Specimen	Tp Treatment Plan	I Image	L Lab	Rx Pharmacy	Sc Scheduling			

"CORE"

Sd SDTM	Qr Data Query	C Correlation	O Organization	P Person	Pa Protocol Abstraction	D Disease	A Agent	Mp Master Problem List	Ay Allergy

"Infra / UTILITY"

Km Knowledge Management	Cm Contract Management	Ev Enterprise Vocabulary	Va Validation	Tx Translation	Au Audit	Id Id Management	Tr Trust Management	Aa Authorization Authentication	Py Policy

caBIG cancer Biomedical Informatics Grid™

Periodic Table of Services

"BUSINESS"

R Registration	**Pt** Protocol	**Oc** Study Outcomes	**Po** Patient Outcomes	**E** Eligibility	**Ae** Adverse Event	**Hx** Hx and Physical	**Dx** Discharge Note	**Ds** Decision Support	**Ra** Referral and Authorization

"CAPABILITY"

Cr Credentialing	**S** Specimen	**Tp** Treatment Plan	**I** Image	**L** Lab	**Rx** Pharmacy		**Sc** Scheduling	

"CORE"

Sd SDTM	**Qr** Data Query	**C** Correlation	**O** Organization	**P** Person	**Pa** Protocol Abstraction	**D** Disease	**A** Agent		**Mp** Master Problem List	**Ay** Allergy

"Infra / UTILITY"

Km Knowledge Management	**Cm** Contract Management	**Ev** Enterprise Vocabulary	**Va** Validation	**Tx** Translation	**Au** Audit

Id Id Management	**Tr** Trust Management	**Aa** Authorization Authentication	**Py** Policy

NCI is continually refining our periodic table of services to reflect the needs of the cancer research and care community

caBIG cancer Biomedical Informatics Grid™

Periodic Table of Services: Expanding the Ecosystem

"CAPABILITY"/"BUSINESS"

R Registration	**Pt** Protocol	**Oc** Study Outcomes	**Po** Patient Outcomes	**E** Eligibility	**Ae** Adverse Event	**Hx** Hx and Physical	**Dx** Discharge Note	**Ds** Decision Support	**Ra** Referral and Authorization

	Cr Credentialing		**S** Specimen		**Tp** Treatment Plan	**Gs** Genome Sequence	**Mn** Microarray Normalization	**Rx** Pharmacy	**Sc** Scheduling

"CORE"

Sd SDTM	**Qr** Data Query	**C** Correlation	**O** Organization	Person	Protocol Abstraction	**Af** Affymetrix Array	**Il** Illumina Array	**D** Disease	**A** Agent	**Mp** Master Problem List	**Ay** Allergy

"Infra / UTILITY"

Km Knowledge Management	**Cm** Contract Management	**Ev** Enterprise Vocabulary	**Va** Validation			**Pr** Protein	**Bm** Biomarker	**Id** Id Management	**Tr** Trust Management	**Aa** Authorization Authentication	**Py** Policy

caBIG cancer Biomedical Informatics Grid™

Usage Patterns for NCI Services

- **Service Specifications:** NCI services layered service specifications (conceptual model, platform independent model and platform specific model) for organizations wishing to build or adapt products that can interoperate with NCI services
- **Reference Implementations:** NCI provides reference implementations of these services that provide Application Programming Interfaces implemented in many technologies
- **NCI Hosted Services:** NCI maintains hosted versions of its services (either standalone or part of larger systems depending on the nature of the service) that are accessible to appropriately authorized entities
- All NCI specifications and reference implementations are made available via a non-viral Open Source license that explicitly allows for commercial, closed source reuse and derivative works

Technology Bindings Utilized by NCI Services

NCI Services are designed to be readily accessed using a variety of technologies. These include:

- **Application Programming Interfaces: Commonly implemented as Remote Enterprise Java Beans (EJB's), but increasingly including API's that utilize .NET frameworks**
- **Grid Services: Access via the NCI's semantically aware SOA infrastructure, caGrid**
- **Web Services: Access via WS-I compliant web services**
- **REST APIs: Simple APIs that allow for easy connection to services but can't utilize the advanced semantic capabilities of caGrid**

NCI is working with FHA to make
NCI Enterprise Services available via the NHIN

Interoperability: Standards

- NCI Services are based, wherever possible, on existing standards to enhance interoperability
- NCI Enterprise Service payloads are derived from the HL7 v3 Reference Information Model and reference relevant standards wherever possible
- NCI Enterprise Services utilize ISO 21090 data types
- NCI Enterprise Services utilize standard controlled biomedical terminologies such as LOINC and the NCI Thesaurus and the ISO 11179 metadata specification

Interoperability: SAIF and ECCF

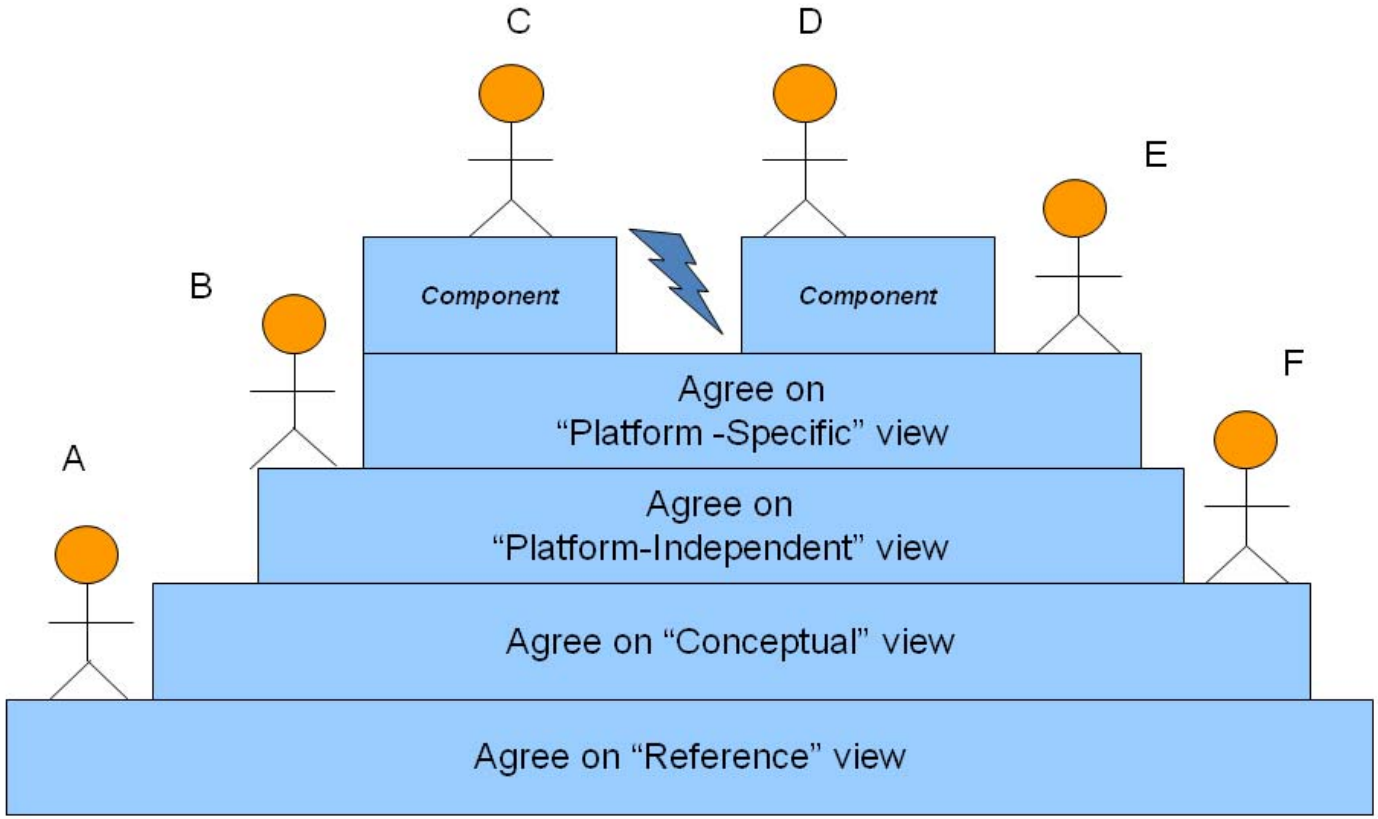
- **The Enterprise Conformance and Compliance Framework (ECCF) is based on the RM-ODP viewpoints and the HL7 Services-Aware Interoperability Framework (SAIF)**
- **Three specification levels: Conceptual Model, Platform Independent Model and Platform Specific Model**

	Enterprise / Business Viewpoint	Information Viewpoint	Computational Viewpoint	Engineering Viewpoint
Model	Governance	Model, Localized Information Model	Collaboration Participations, Contracts Parts	etc.
Platform Specific Model	Rules, Procedures	Localized Information Model Transforms, Schema	Collaboration scripts, Orchestrations, Realized Interfaces	Execution Context, Platform Bindings, Deployment Model

Our purpose with SAIF and ECCF is to enable "Working Interoperability"

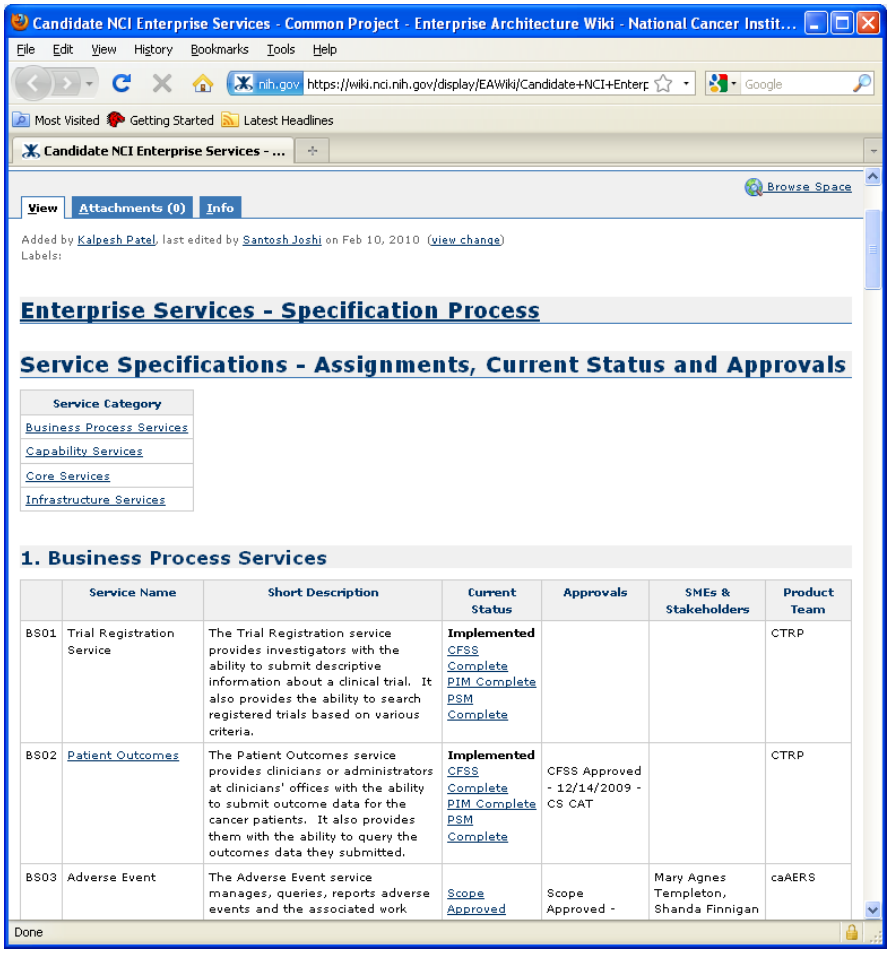
caBIG cancer Biomedical Informatics Grid™

Interoperability: Multiple Levels Based on ECCF Specifications



Additional Information

- **NCI service specification and development is an open process; all artifacts are available at the NCI wiki***
- **NCI welcomes all interested parties to participate in the service specification and development process**



* https://wiki.nci.nih.gov/display/EAWiki/Candidate+NCI+Enterprise+Services

“I'm looking for a lot of men who have an infinite capacity to not know what can't be done.”

- Henry Ford

“To achieve great things, two things are needed: a plan, and not quite enough time”

- Leonard Bernstein

Thank You