Information Technology for the Health Care Enterprise

Ram D. Sriram, Ph.D.

Chief, Software and Systems Division

URL: http://www.nist.gov/itl/ssd/

sriram@nist.gov

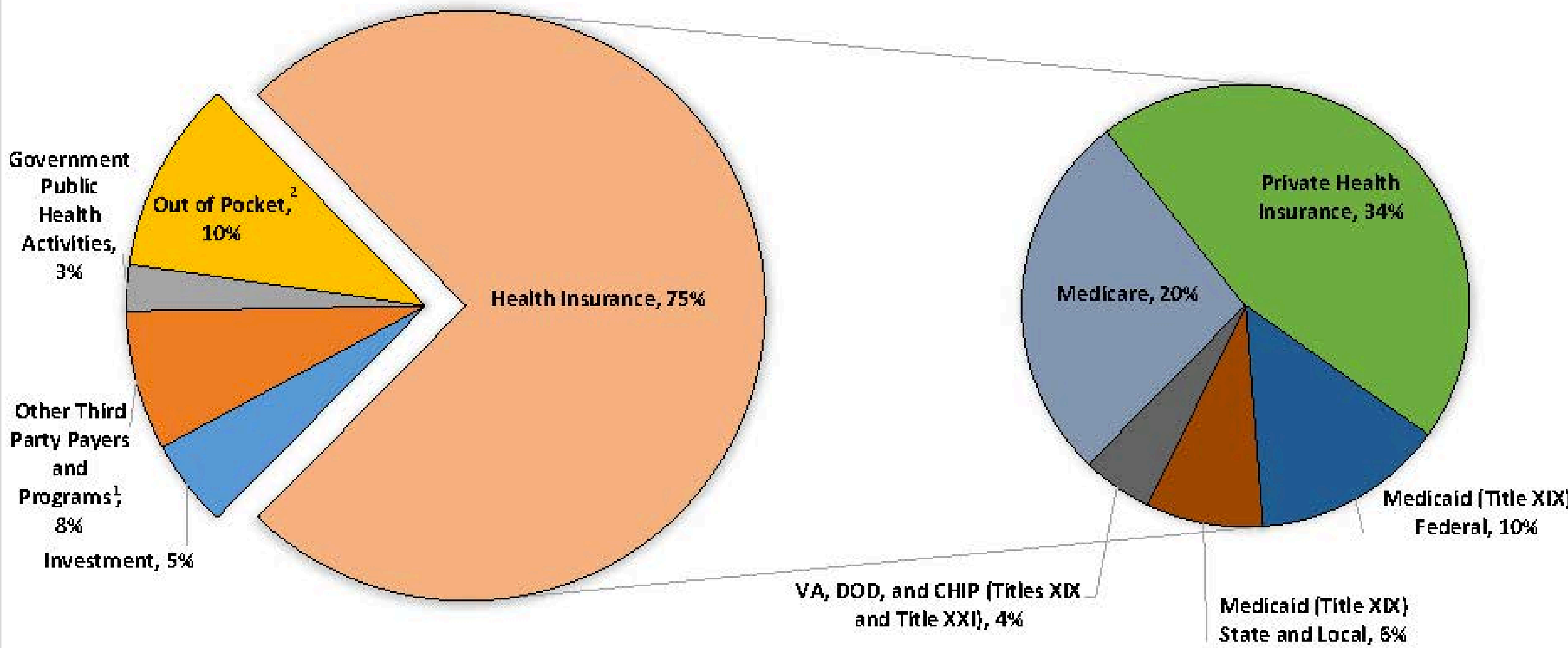
Outline

- Healthcare Vision
- Health IT at NIST
- Standards & Testing
- Security
- Biomedical Imaging
- Bioinformatics
- Summary

Healthcare Facts

- $3.5 Trillion dollars spent in 2017 on healthcare in the U.S. (http://www.cms.gov)
- It is estimated that approximately $750billion is lost due to inefficiencies in the system
  - Effective use of IT may help reduce these costs
- Multiple parties playing different roles

THE NATION'S HEALTH DOLLAR ($3.5 TRILLION), CALENDAR YEAR 2017: WHERE IT CAME FROM



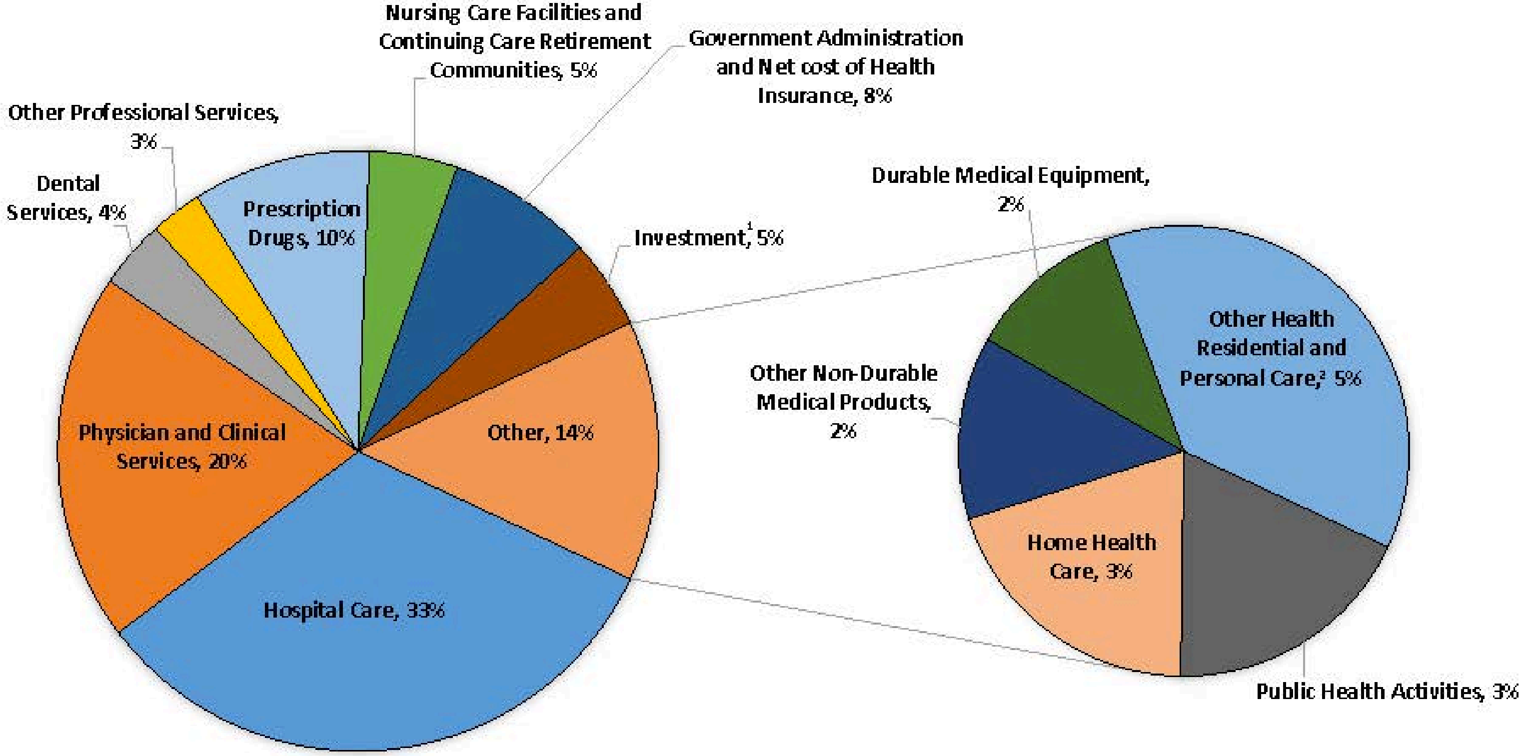
[1] Includes worksite health care, other private revenues, Indian Health Service, workers' compensation, general assistance, maternal and child health, vocational rehabilitation, Substance Abuse and Mental Health Services Administration, school health, and other federal and state local programs.

[2] Includes co-payments, deductibles, and any amounts not covered by health insurance.

Note: Sum of pieces may not equal 100% due to rounding.

SOURCE: Centers for Medicare & Medicaid Services, Office of the Actuary, National Health Statistics Group.

THE NATION'S HEALTH DOLLAR ($3.5 TRILLION), CALENDAR YEAR 2017, WHERE IT WENT



[1] Includes Noncommercial Research and Structures and Equipment.

[2] Includes expenditures for residential care facilities, ambulance providers, medical care delivered in non-traditional settings (such as community centers, senior citizens centers, schools, and military field stations), and expenditures for Home and Community Waiver programs under Medicaid.

Note: Sum of pieces may not equal 100% due to rounding.

SOURCE: Centers for Medicare & Medicaid Services, Office of the Actuary, National Health Statistics Group.

Levels of Biological Information

HEALTH CARE

Ecologies

Societies/Populations

Individuals

Organs

BIOSCIENCES

Tissues

Cells

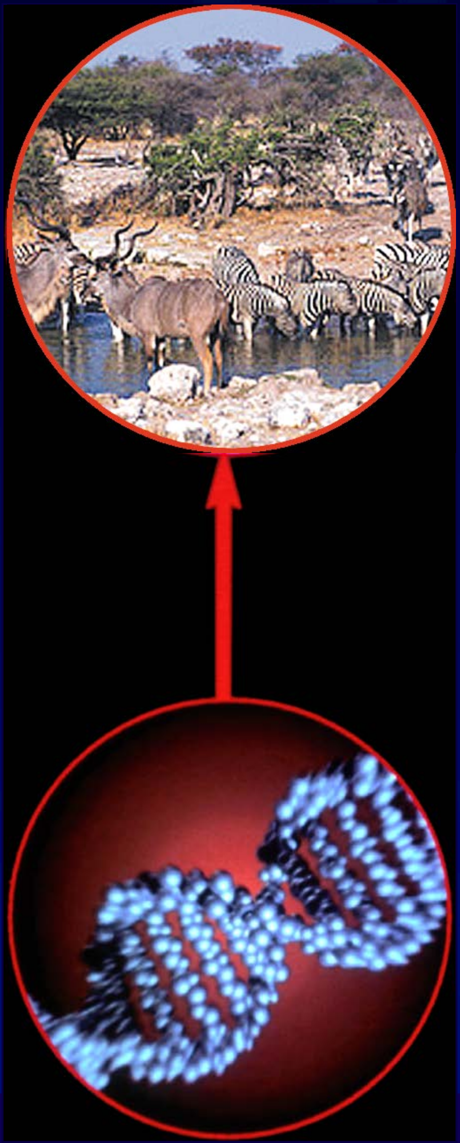
Protein and gene networks

Protein interaction networks

Protein

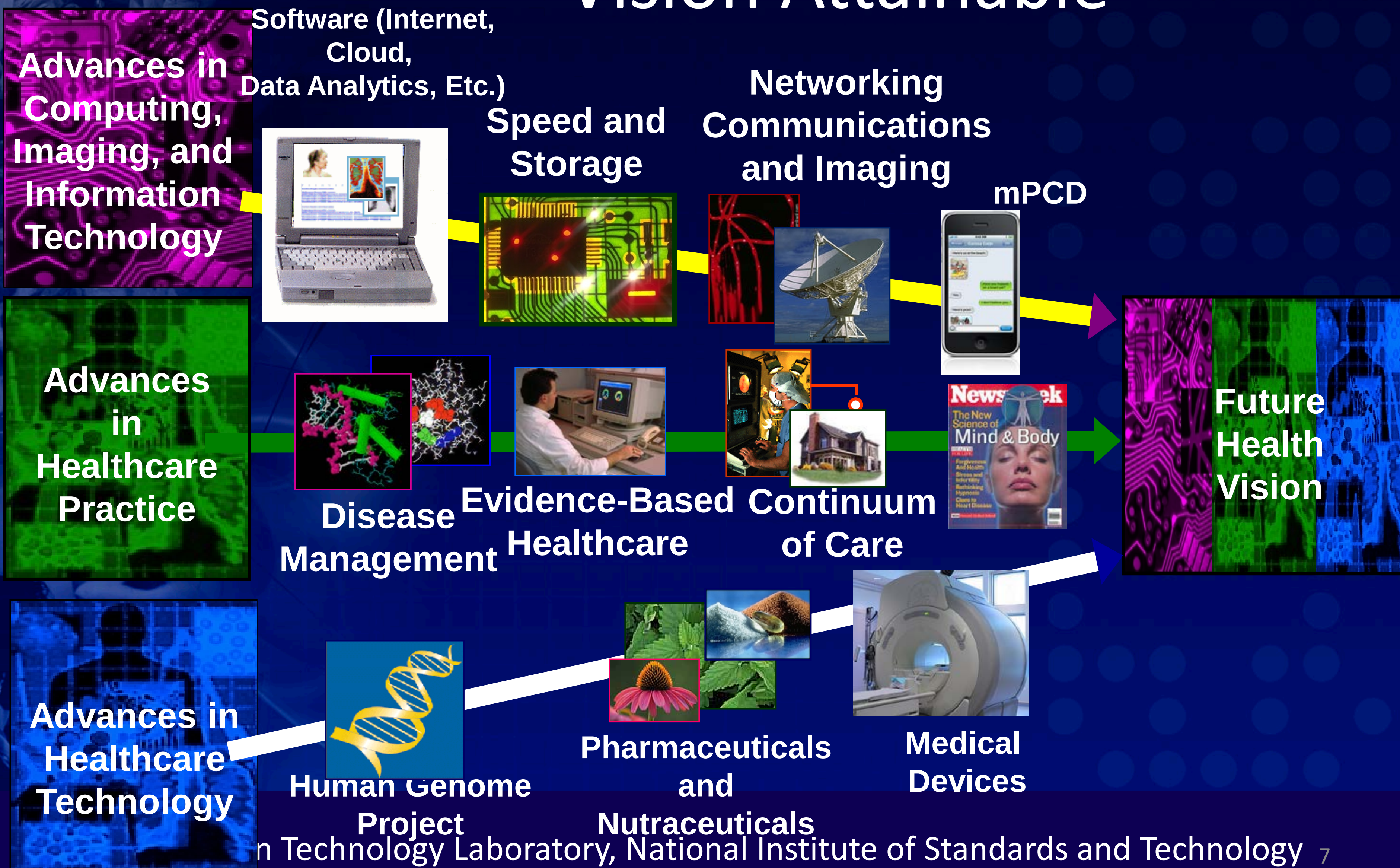
mRNA

DNA



Hood

Advances Making Future Health Vision Attainable



Courtesy: Jack Corley

The P7 Concept

1. Personalized
2. Predictive
3. Participatory
4. Precise (recommendation, decision analytics)
5. Preventive
6. Pervasive (including point of care)
7. Protective (Privacy and security)

Based on discussions with Leroy Hood and Ramesh Jain

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Key Activities in Health IT

- NIST enables **interoperability** and **adoption** by:
  - Accelerating **standards** development and harmonization
  - Developing a conformance **testing** infrastructure
  - Expanding R&D and deployment of **security** protocols
  - Leveraging testing infrastructure to assist with **certification** process
- Leading to an emerging health IT network that is correct, complete, secure and testable.
- In addition to exploring standards and measurements for emerging technologies in health care.

Image: Shutterstock, ©Jenny Horne

NIST Health Care: IT Projects

- Health Information Technology: Standards & Testing
- Medical Devices: Interoperability
- Biomedical Imaging
- Bioinformatics
- Text Retrieval (Past)
- Usability (Past)
- Security

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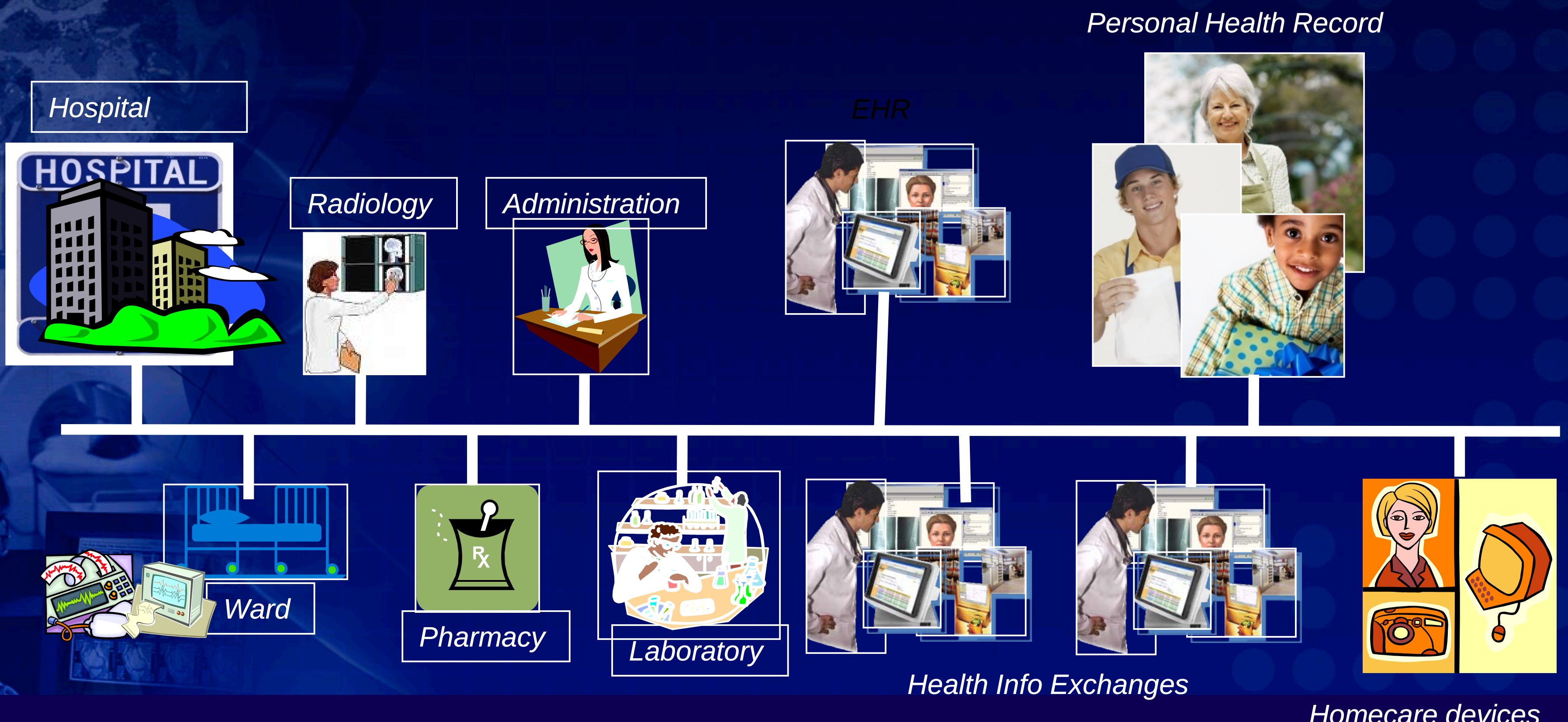
Standards and Testing

Provide technical expertise to leverage industry-led, consensus-based standards development and harmonization as well as develop a conformance testing infrastructure to enable interoperability and adoption.

Key activities include:

- Developed the conformance test method (test procedures, test data, and test tools) to ensure compliance with the Stage 1 and Stage 2 Meaningful Use technical requirements and standards
- Under HITECH, developing a health IT standards testing infrastructure to provide a scalable, multi-partner, automated capability for current and future testing needs within the healthcare domain.
- Developing conformance test tools for fully integrated health IT systems to assure that the standards are implemented consistently.
- Collaborating with industry including Health Level Seven (HL7), IEEE, and Integrating the Healthcare Enterprise (IHE).

Health IT Interoperability



EHRs: Key Issues

SECURITY

- Input (user interfaces)
- Store (representation and persistency)
- Manipulate (search, mining, knowledge creation)
- Exchange (syntactic and semantic interoperability)

Interoperability

Electronic Health Record

Electronic Health Record

Electronic Health Record

Electronic Health Record (EHR) System ⟷ Electronic Health Record (EHR) System

Electronic Health Record (EHR) System ⟷ Laboratory Information systems (LIS)

Electronic Health Record (EHR) System ⟷ Public Health

Electronic Health Record

LIS

Public Health
Prevent. Promote. Protect.

Interoperability

Electronic Health Record

Electronic Health Record (EHR) System

Pharmacy

Electronic Health Record

Electronic Health Record (EHR) System

Medical Device

Medical Device

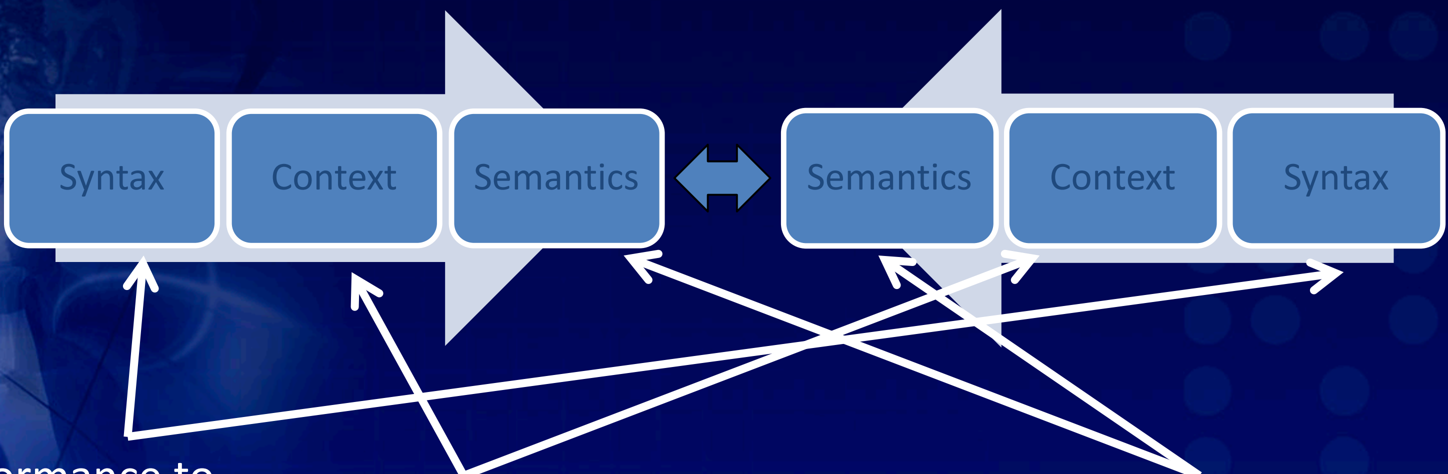
Medical Device

Semantic Mapping Techniques
The Medical "Tower of Babel"

Some terms for "Hypersomatotropic Gigantism":

Vocabulary	Term
UMLS Metathesaurus	Hypersomatotropic Gigantism
ICD-9-CM	No direct translation
MeSH	No direct translation
DXplain	Pituitary Gigantism
Read Codes	No direct translation
SNOMED	Hypersomatotropic Gigantism

True EHR Interoperability



Conformance to raw message specifications in the Standard

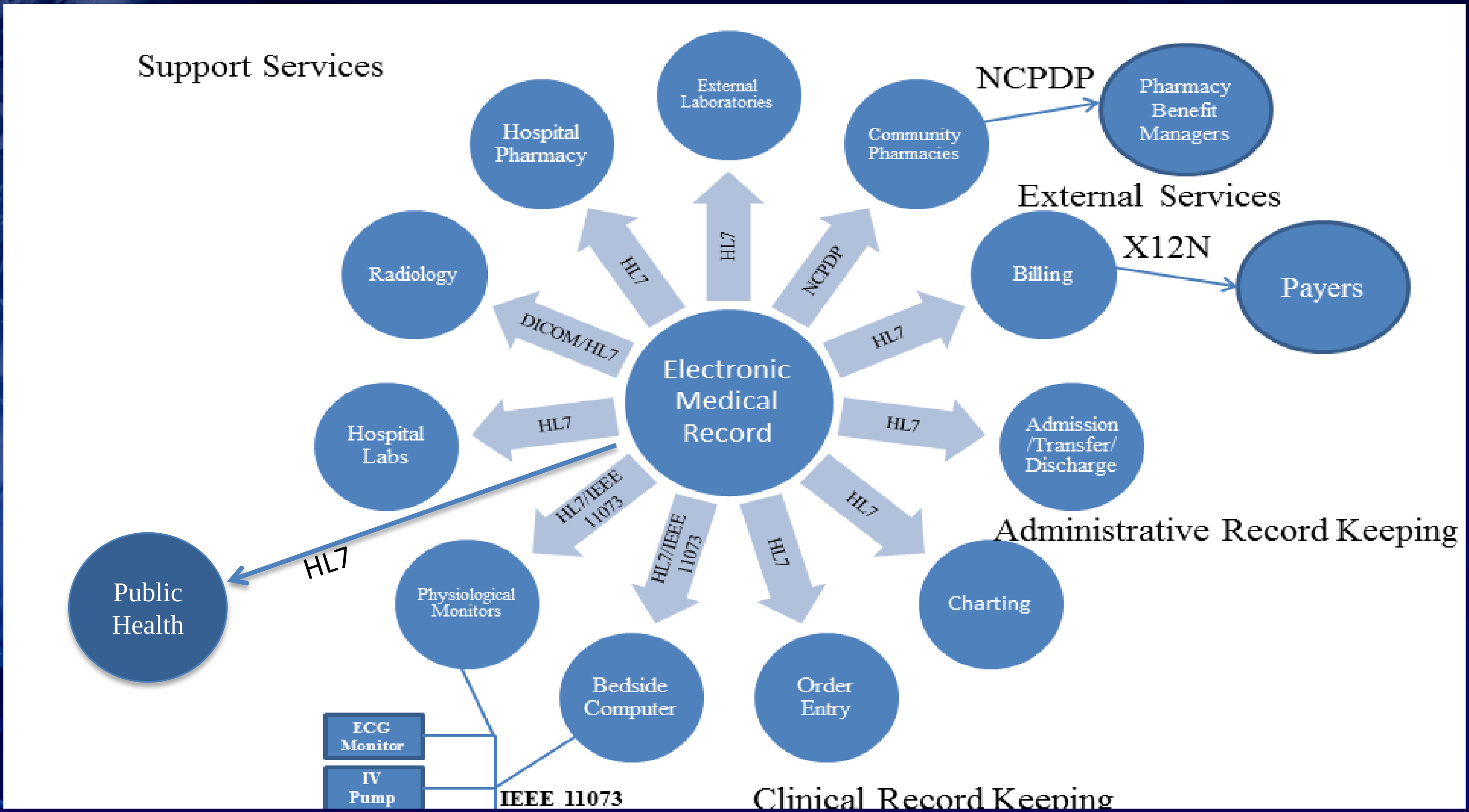
Conformance to Specific Clinically Relevant Test data to exercise all options

Conformance to Specified Vocabularies in clinically relevant test data

Interoperability

- **<u>Standards</u>** are essential to achieving conformance and interoperability
- R***igorous*** testing is critical to achieving **<u>conformance</u>** and enabling **<u>interoperability</u>**
- Conformance CAN NOT be definitively determined* - but gives a level of confidence based on quality and quantity of test(s) performed
(*unless specification is very basic)
- Conformance  Interoperability
  - A is Conformant, B is Conformant
    - The above does not say anything about interoperability between A and B

Standards That Link to an EHR



Standards in HealthCare

- Terminology
  - SNOMED, LOINC
- Classification Systems
  - ICD9 & 10, CPT
- Devices
  - IEEE 11073
- EHR-Related
  - DICOM, HL7 (CDA)
- Interoperability
  - DICOM, HL7 Messaging, HIPAA Transactions, NCPDP
- Language Formats
  - XML, X12
- Internet Protocols
  - HTTP/HTTPS → TCP/IP

Four Levels of HIT Interoperability

high ↕ low

automatic ↕ manual

Organizational Interoperability

Standardized process (workflow) elements using business process modeling tools

Semantic Interoperability

Standardized meaning (model element) and terms / vocabulary for data interpretation, e.g., LOINC, ICD-10CM

Syntactic Interoperability

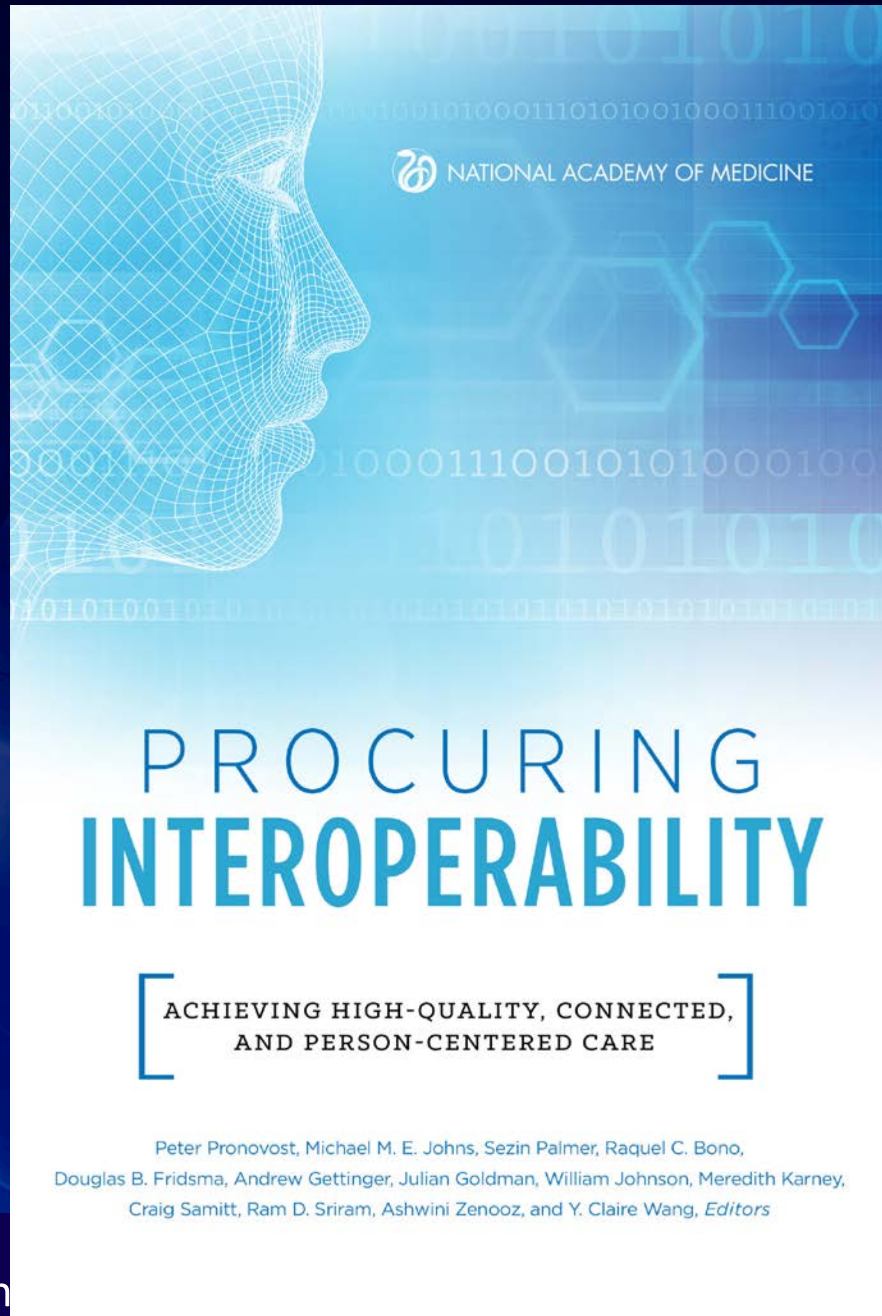
Standardized data exchange formats, e.g., HL7, XML

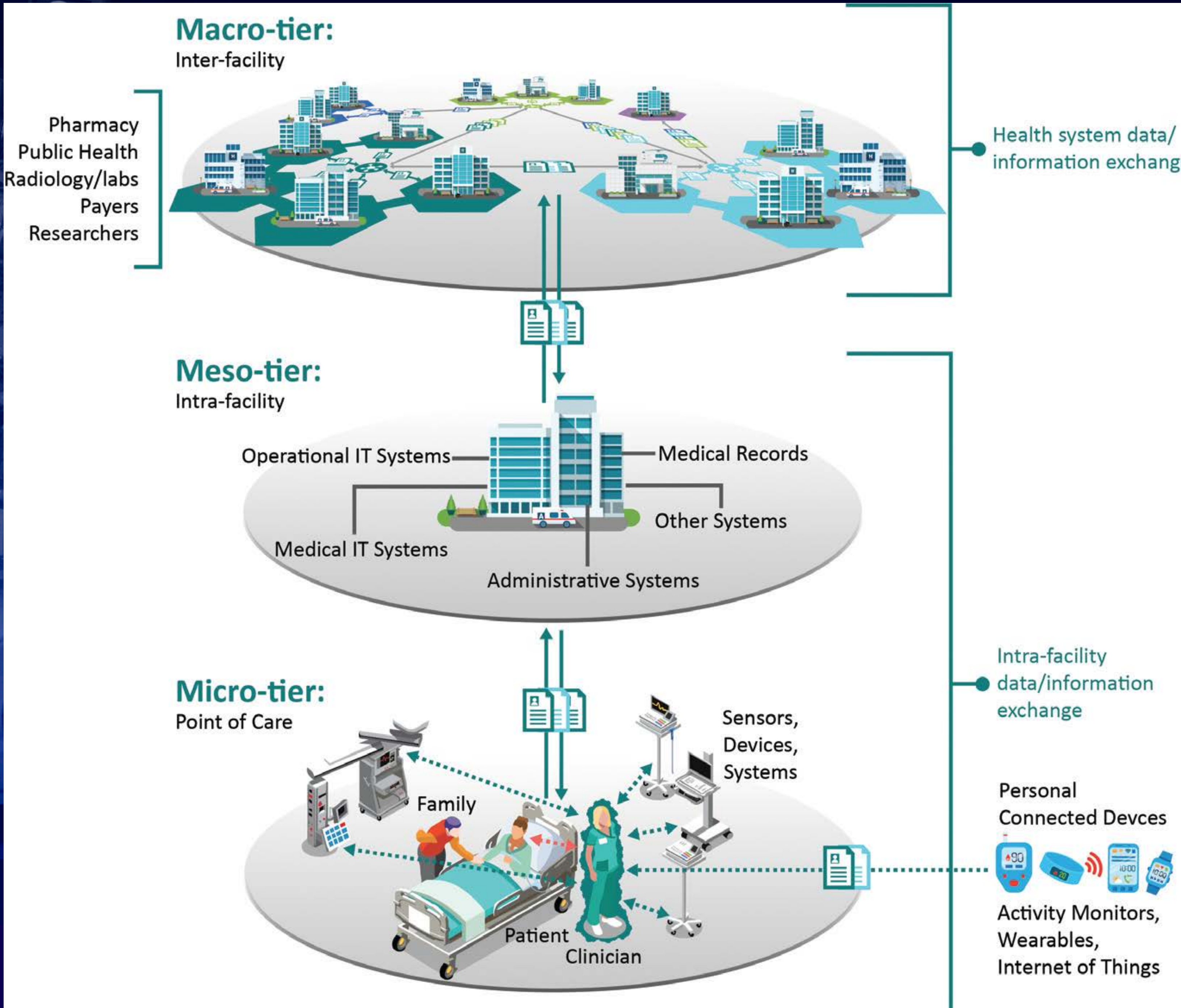
Technical Interoperability

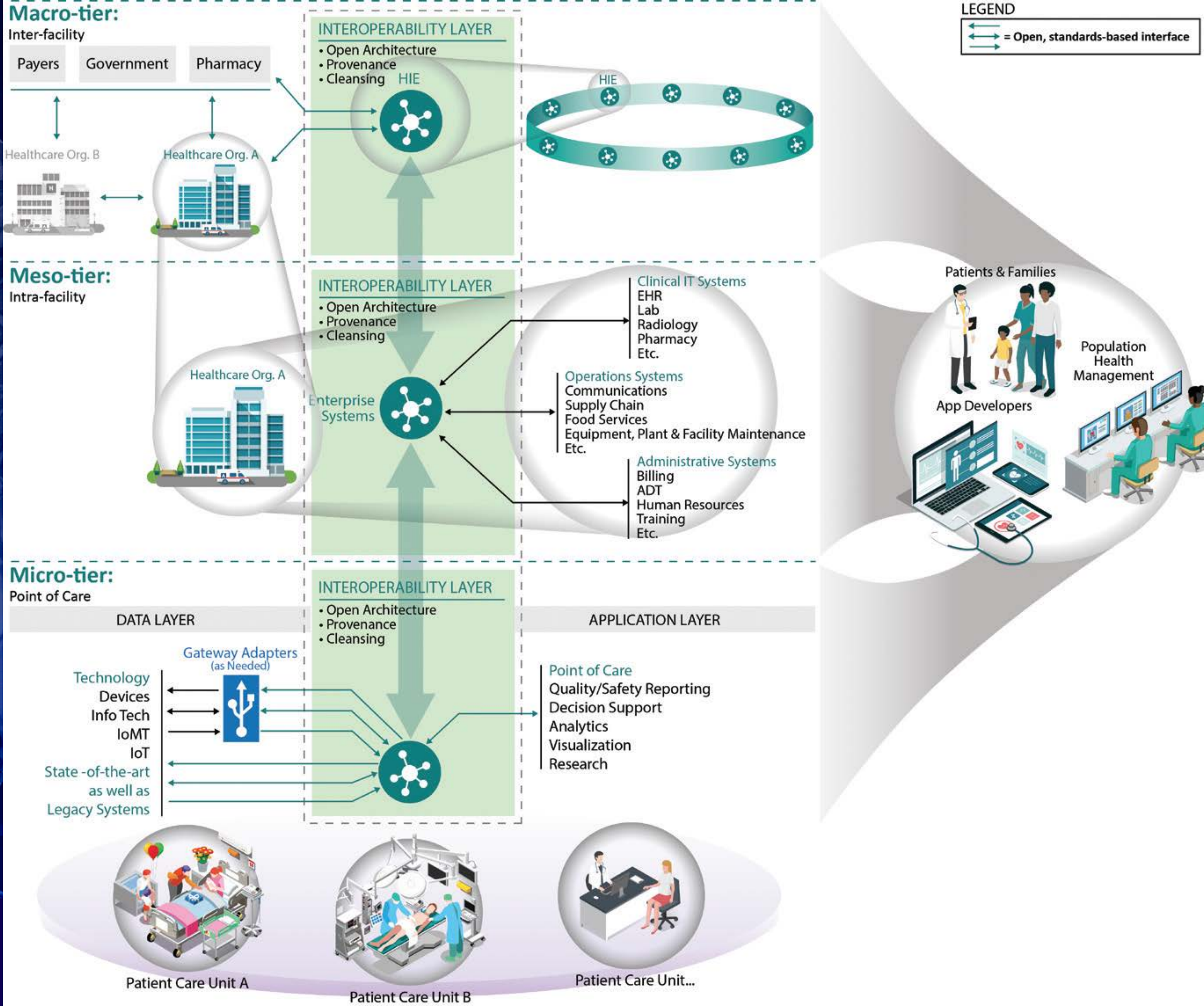
Signals using standard protocols for technically secure data transfer, e.g., TCP/IP

Standards

Based on
Oemig F, Snelick R, Healthcare Interoperability Standards Compliance Handbook. Springer International Publishing Switzerland. 2016. Page 13, Figure 1.3.


NATIONAL ACADEMY OF MEDICINE
PROCURING
INTEROPERABILITY
ACHIEVING HIGH-QUALITY, CONNECTED, AND PERSON-CENTERED CARE
Peter Pronovost, Michael M. E. Johns, Sezin Palmer, Raquel C. Bono,
Douglas B. Fridsma, Andrew Gettinger, Julian Goldman, William Johnson, Meredith Karney,
Craig Samitt, Ram D. Sriram, Ashwini Zenooz, and Y. Claire Wang, Editors


Macro-tier:
Inter-facility
Pharmacy
Public Health
Radiology/labs
Payers
Researchers
Health system data/
information exchange
Meso-tier:
Intra-facility
Operational IT Systems
Medical Records
Other Systems
Medical IT Systems
Administrative Systems
Micro-tier:
Point of Care
Sensors,
Devices,
Systems
Family
Patient
Clinician
Intra-facility
data/information
exchange
Personal
Connected Devces
Activity Monitors,
Wearables,
Internet of Things



LEGEND
= Open, standards-based interface
Macro-tier:
Inter-facility
Payers
Government
Pharmacy
Healthcare Org. B
Healthcare Org. A
INTEROPERABILITY LAYER
• Open Architecture
• Provenance
• Cleansing
HIE
HIE
Meso-tier:
Intra-facility
INTEROPERABILITY LAYER
• Open Architecture
• Provenance
• Cleansing
Healthcare Org. A
Enterprise Systems
Clinical IT Systems
EHR
Lab
Radiology
Pharmacy
Etc.
Operations Systems
Communications
Supply Chain
Food Services
Equipment, Plant & Facility Maintenance
Etc.
Administrative Systems
Billing
ADT
Human Resources
Training
Etc.
Patients & Families
Population Health Management
App Developers
Micro-tier:
Point of Care
DATA LAYER
INTEROPERABILITY LAYER
• Open Architecture
• Provenance
• Cleansing
APPLICATION LAYER
Gateway Adapters
(as Needed)
Technology
Devices
Info Tech
IoMT
IoT
State -of-the-art
as well as
Legacy Systems
Point of Care
Quality/Safety Reporting
Decision Support
Analytics
Visualization
Research
Patient Care Unit A
Patient Care Unit B
Patient Care Unit...

Challenges with HIT Interoperability Standards

- Standards can be non-existent for certain doma
- Existing standards can be poorly defined
- Poorly-defined standards can be poorly implemented
- Well-defined standards can be poorly implemen
- Well-defined standards can be ignored (i.e., not adopted)
- Standards can compete with each other (too many standards)
- Standards can be complex

Use of Standards doesn't guarantee Interoperability

Common Issues with HIT Standards

- Under specified
- Multiple solutions (occurs at all levels)
- Conflation of requirements (requirement scoping
- Document current state—not desired state
- Not specific enough—e.g., code system binding
- Too specific
- Poor documentation and typos
- Lack of a consistency
- Conditions w/o Condition Predicates
- Absence of harmonized requirement specification methodology
- Insufficient requirement specification mechanisms
- Lack of reference and pilot implementations
- Lack of testing
- Improper scoping

NIST Standard Activities/Working Group Participation

Government

Office of the National Coordinator (ONC)	• **Health IT Standards Committee** – Ram D. Sriram
OTHERS	• Cross Federal Workgroup on Telehealth (FedTel) – Ram D. Sriram and John Garguilo • HITRD/NITRD – Ram D. Sriram
Integrating the Healthcare Enterprise (IHE)	• **Patient Care Devices (PCD) Technical Committee** – Co-Chair John Garguilo • **Patient Care Devices (PCD) Planning Committee** – John Garguilo • **IT Infrastructure (ITI) Planning Committee** – Bill Majurski • **IT Infrastructure (ITI) Technical Committee** – Bill Majurski • **Testing and Tools Committee** – Bill Majurski, Robert Snelick, John Garguilo
Health Level 7 (HL7)	• **Conformance & Guidance WG** – Co-Chair Robert Snelick • **Healthcare Devices WG** – Co-Chair John Garguilo • **FHIR WG** – Bill Majurski • **Immunization WG** – Sandra Martinez
IEEE	• **IEEE 11073 Medical Device Communications** – John Garguilo
NCPDP	• **Meaningful Use WG11** – Kevin Brady

Industry

The American Recovery and Reinvestment Act (ARRA) identifies NIST to lead the development of a health IT testing infrastructure

- ARRA (2009) emphasizes the need to move toward electronic health records
- The legislation calls for National Institute of Standards and Technology (NIST) to contribute:
  - Ensure health IT standards are complete and robust
  - Establish a health IT standards testing infrastructure that supports industry consensus standards development and provides robust conformance and interoperability testing capabilities
  - Deploy those technologies to promote interoperable health IT adoption

Proposed Stages of Meaningful Use

Stage 1

- Electronically capturing health information in a coded format
- Using that information to track key clinical conditions
- Communicating that information for care coordination purposes
- Initiating the reporting of clinical quality measures and public health information

Stage 2

- Stage 1 objectives
- Disease management
- Clinical decision support
- Medication management
- Support for patient access to their health information
- Quality measurement and research
- Bi-directional communication with public health agencies

Stage 3

- Stage 1 and 2 objectives
- Improvement in quality, safety and efficiency
- Decision support for national high priority conditions
- Access to self management tools
- Access to comprehensive patient data and improving population health outcomes

NIST And MU

- NIST developed the tests for compliance with the MU criteria.

NIST Role in ARRA MU EHR Certification Stage 1

MU Recommendations from ARRA HIT Policy and Standards Committees

CMS Final Rule – Meaningful Use Objectives and Measures

ONC Final Rule – Certification Criteria and Standards

ONC-Approved Test Method

Test Procedures
Test Data
Conformance Tools

Based on the requirements in the ONC Final Rule, NIST published 45 test procedures which are in use by the accredited testing laboratories to test and certify EHR products for the Meaningful Use Program

ATCB Test Scripts

ATCB Testing of EHRs

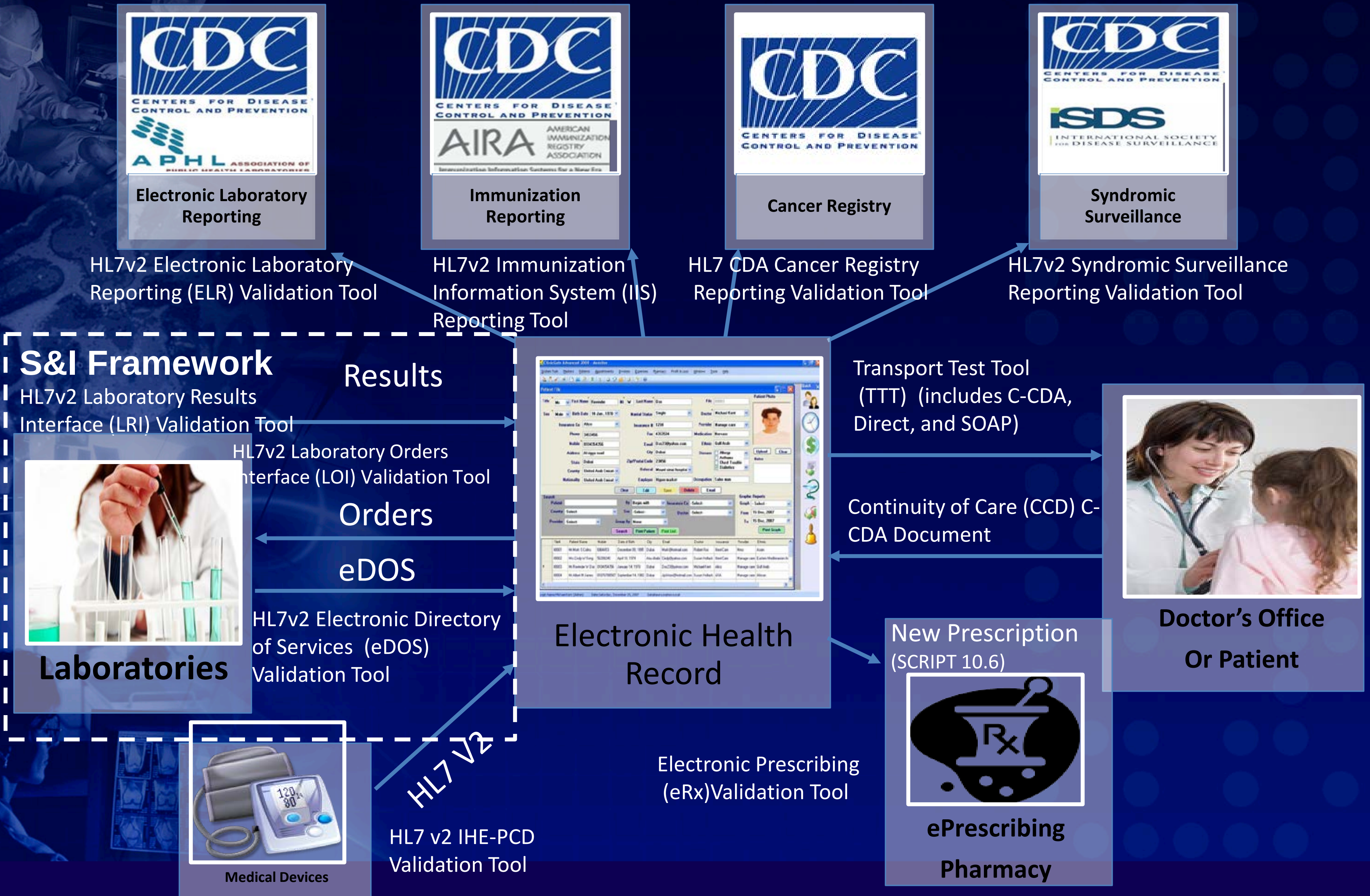
ONC Certified Products List

Accredited Testing and Certification Bodies**

Drummond Group, Inc. Complete EHR and EHR Modules.
InfoGard Laboratories, Inc. –Complete EHR and EHR Modules.
ICSA Labs - Complete EHR and EHR Modules.
SLI Global Solutions Complete EHR and EHR Modules.
Surescripts LLC - EHR Modules: E-Prescribing, Security

** Set up by NVLAP

NIST Tooling for Stage II and Stage III



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How we accomplished MU 2

HL7 CDA Cancer Registry Reporting Validation Tool	Partner with CDC Four separate divisions
HL7v2 Immunization Information System (IIS) Reporting Validation Tool	
HL7v2 Syndromic Surveillance Reporting Validation Tool	
HL7v2 Electronic Laboratory Reporting (ELR) Validation Tool	
Transport Test Tool (TTT) (includes C-CDA, Direct, and SOAP)	Partner with DIRECT Project/NwHIN
Electronic Prescribing (eRx)	Partner with NCPDP Established MU WG
HL7v2 Laboratory Results Interface (LRI) Validation Tool	Partner with S&I Framework

NIST's Tools are foundations for MU implementations

Improved Quality, Access, and Cost of Healthcare

Meaningful Use (MU) Attestation by Eligible Entities

Meaningful use of CEHRT by Eligible Entities

CEHRT Configuration and Implementation at Eligible Entities' Sites

EHR Certification Testing using Test Tools

Development of Conformance Test Tools by **NIST**

Development of IG Standards & Other Specifications by Work Groups (with **NIST** participation)

28 Billion Dollars

CMS
MU
Incentive
Payments
to
Eligible
Entities

$10's of Billions

Quality of the CEHRT implementations and the installed sites is directly related to the quality of the Conformance Test Tools and the underlying standards

Resolving interoperability problems is much less expensive during standards development and testing; after CEHRT deployment these problems would need to be resolved at numerous locations

A few $M

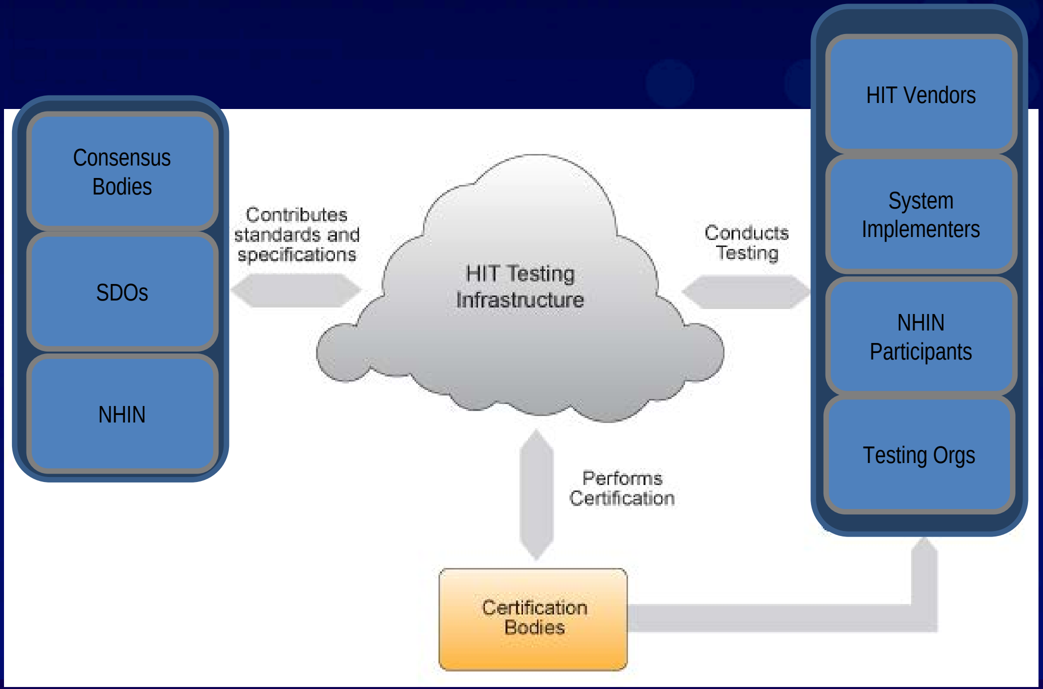
CEHRT = Certified EHR Technology

21st Century Cures Act (Dec. 2016) Sec. 4003. Interoperability

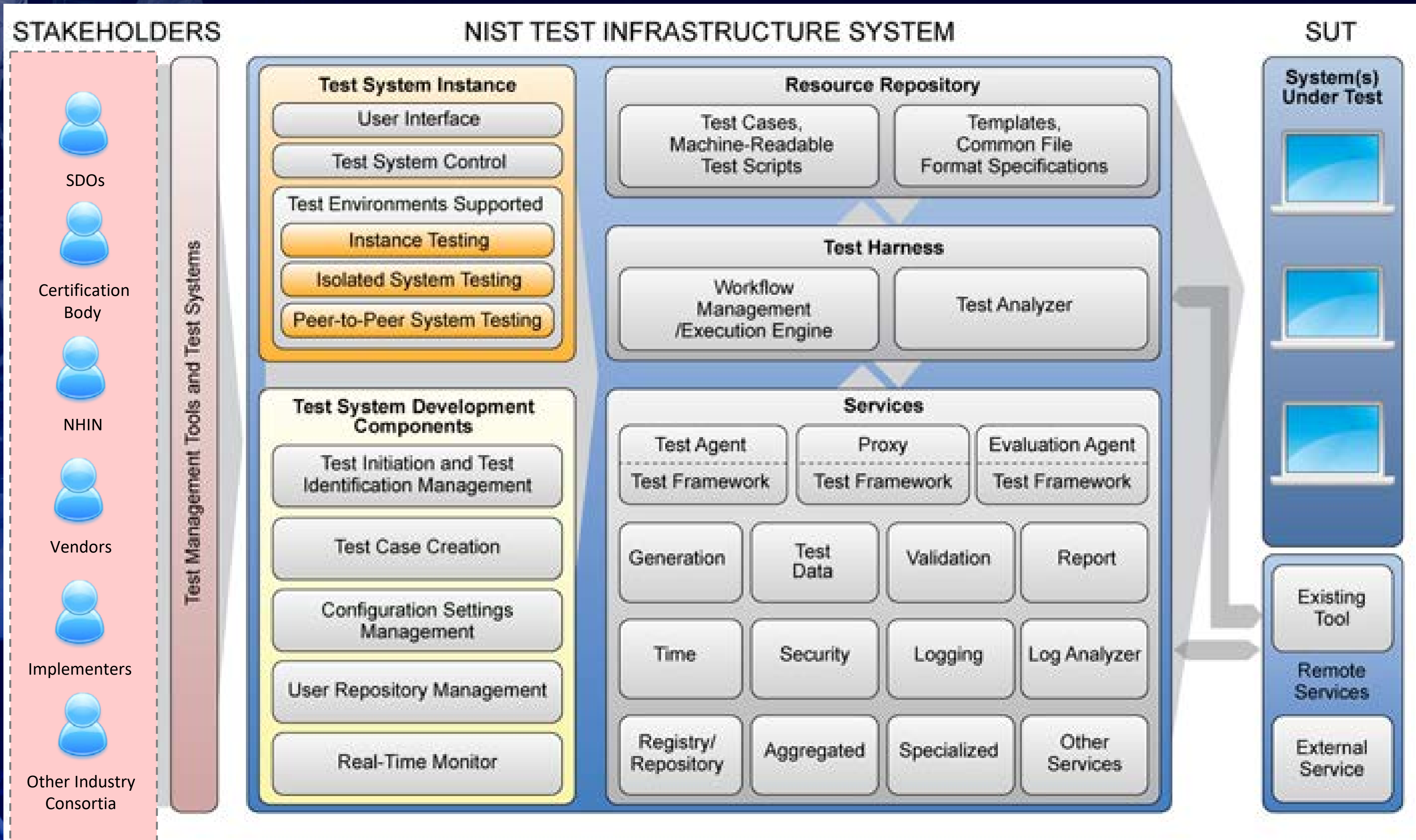
The National Coordinator shall, in collaboration with the National Institute of Standards and Technology and other relevant agencies within the Department of Health and Human Services, for the purpose of ensuring full network-to-network exchange of health information, convene public-private and public-public partnerships to build consensus and develop or support a trusted exchange framework, including a common agreement among health information networks nationally. Such convention may occur at a frequency determined appropriate by the Secretary.

The NIST Testing Infrastructure ….
…. *will provide a scalable, automated environment for current and future testing needs*

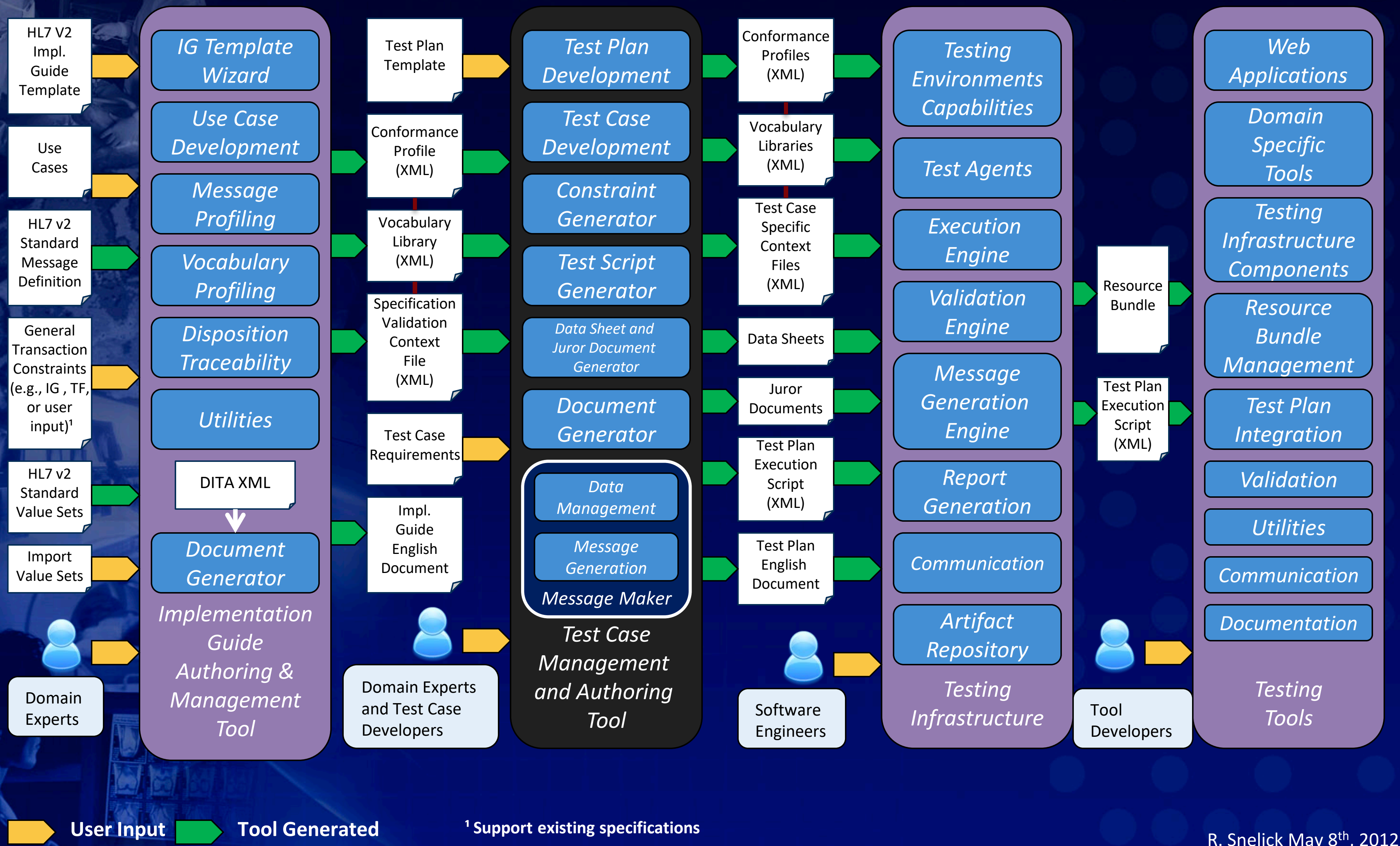
- NIST will collaborate with health IT stakeholders to harmonize healthcare standards test development and delivery to ensure conformance and interoperability within the healthcare domain
- NIST will leverage existing tools and work with health IT stakeholders including:
  - Certification Bodies
  - Testing Organizations
  - NwHIN
  - Vendors
  - Implementers
  - SDOs
  - Other Industry Consortia



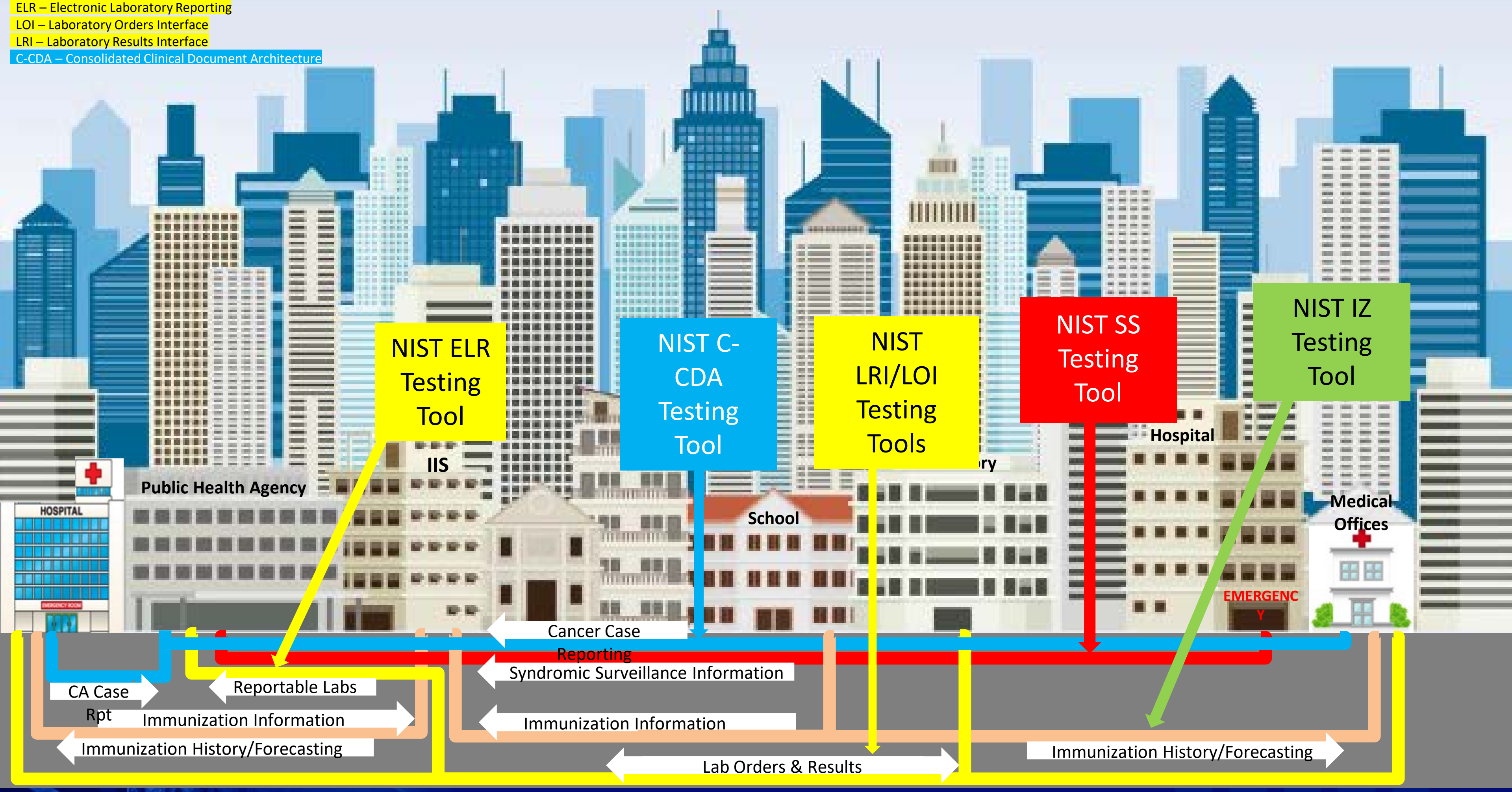
Conceptual View of HIT Testing Infrastructure



The Big Picture: HL7 V2 End-to-end Testing Support



NIST – National Institute of Standards and Technology
IZ – Immunization
SS – Syndromic Surveillance
ELR – Electronic Laboratory Reporting
LOI – Laboratory Orders Interface
LRI – Laboratory Results Interface
C-CDA – Consolidated Clinical Document Architecture



Medical Devices

- Interoperability
- Body Area Network Standards
- Security

NIST
Medical Device Communication Testing

Semantic interoperability of Medical Devices

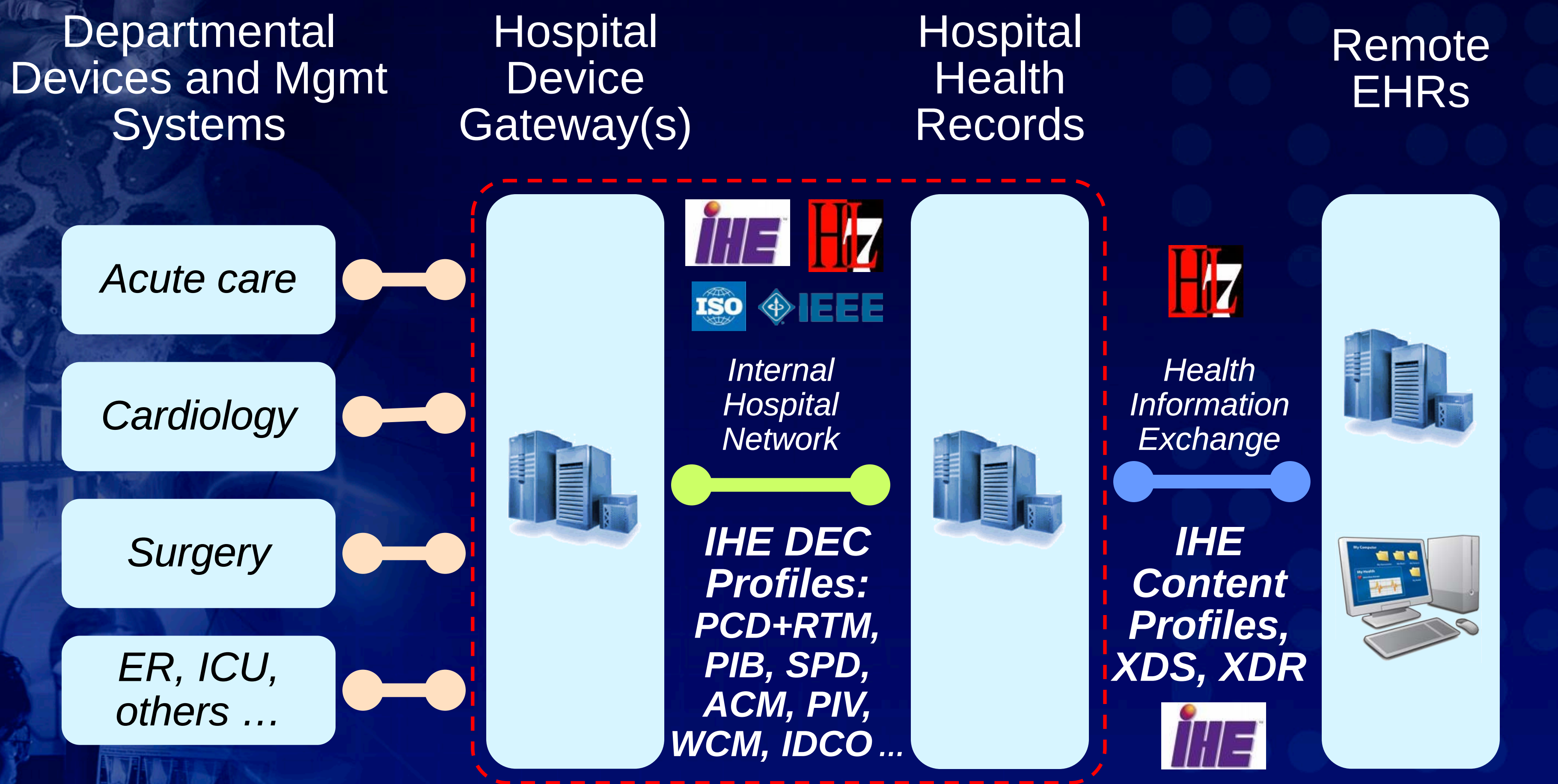
Information Technology Laboratory, National Institute of Standards and Technology

Introduction - Need

As hospitals deploy EMRs into their most critical care areas, the need to acquire data directly from medical devices becomes increasingly evident.

- Device data capture is “real-time”
  - Data is up-to-date
  - Decision support algorithms can run on more timely data
- Device data capture is “automatic”
  - Reduce nursing workload
- Device data capture is “accurate”
  - Automated data capture is less error prone than manual charting

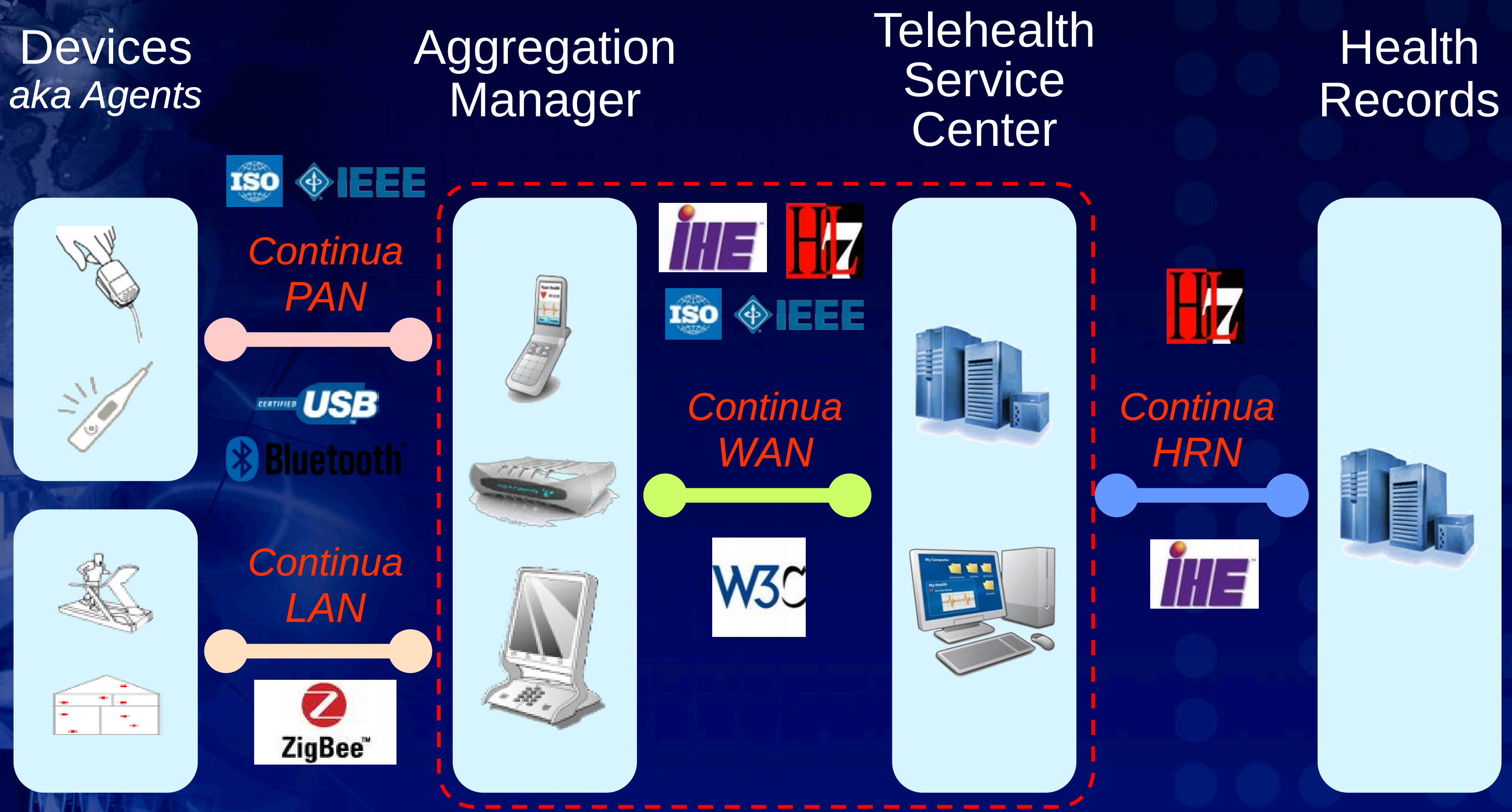
Patient Care Health Device Connectivity



Note: *IHE Profiles shown above were recently (March 2016) demonstrated at HIMSS16;*
IHE DEC PCD-01 *Technical Framework "Final Text" version first became available in Q3 2011.*

Slide developed and provided by Paul Schluter, GE Healthcare

Personal Health Device Connectivity



Note: Continua 2014 Version (and subsequent updates) Guidelines available today; The Continua WAN interface uses the IHE DEC PCD-01 transaction over Web Services.

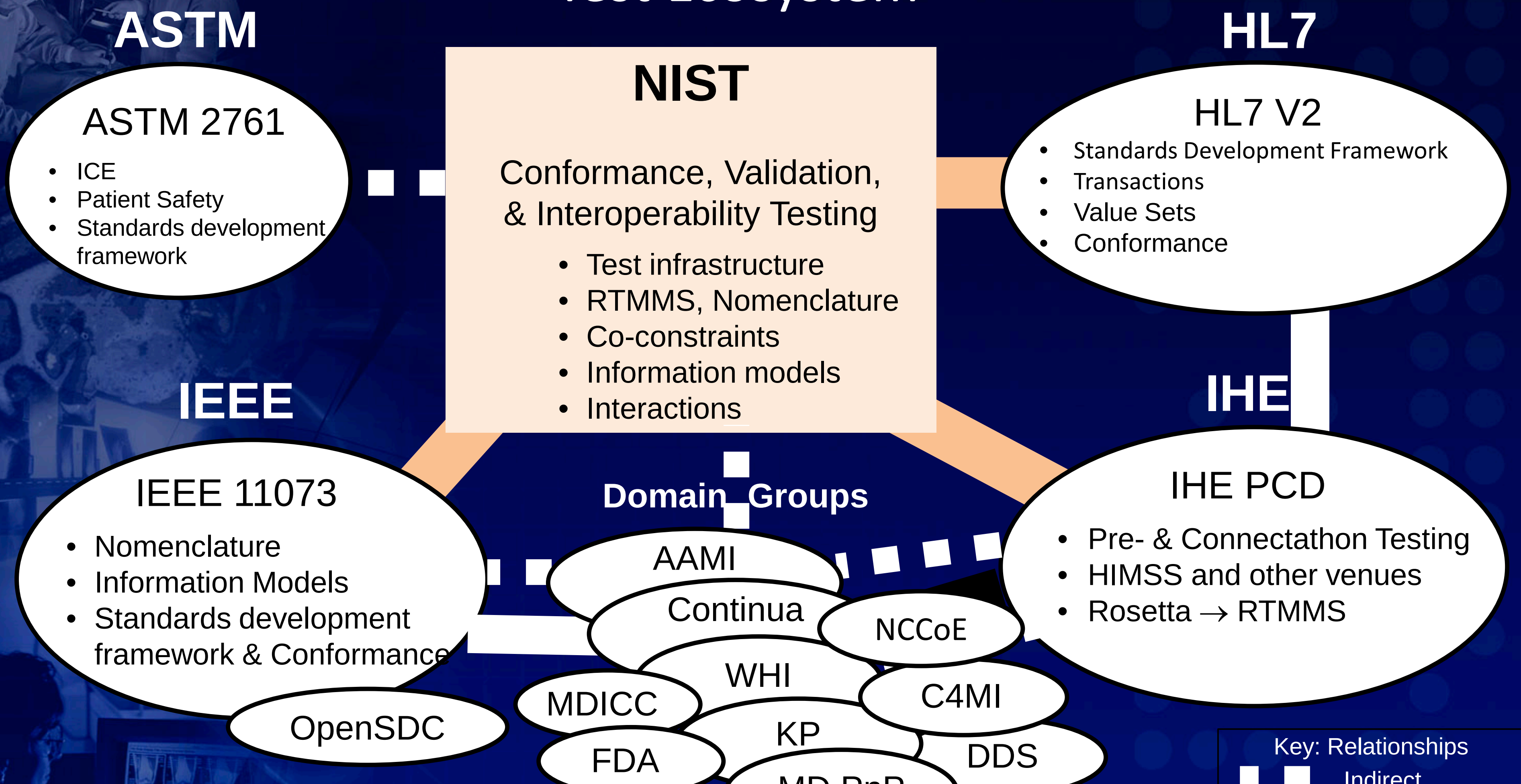
Slide developed and provided by Paul Schluter, GE Healthcare

Problem Space Addressed through test methods
How can we Improve Interoperability?

The NIST Approach…

- Use **standards** to provide more economically effective solutions by amortizing the cost of design over many implementations.
- **Profile standards** to reduce optionality and simplify implementation and testing.
- Provide **computable definitions** of message syntax and semantics as well as information models.
- Use **rigorous conformance** (which in turn, used for certification and conformity assessment testing).
- Use other incentives to promote acceptance …

NIST, SDOs, and (Medical Device) Domain Groups Test Ecosystem



CIMIT: Center for Integration of Medicine and Innovative Technology
AAMI: Assoc. for Advancement of Medical Instrumentation
TATRC: Telemedicine and Advanced Technology Research Center
MDICC: Medical Device Interoperability Coordination Council
Continua: Continua Health Alliance
OpenSDC: System & Device Connectivity
NCCoe – NIST National Cybersecurity Center of Excelence

KP: Kaiser-Permanente
WHI: West Health Institute
C4MI: Center for Medical Interoperability
FDA: Food & Drug Administration
MD PnP: Medical Device Plug-n-Play
ICE: Integrated Clinical Environment
DDS: OMG Data-Distribution Service

Work Products: Standards, Domains & NIST Test Tools

Medical Device Domain

- IHE-PCD
- HL7 – Health Level 7

Device-to-EHR/EMR

- ISO/IEEE 11073 Medical Device Communication - Family of Standards

Device-to-Device

Model: Manager <-> Agent
(Receives Data) (Provides data)

NIST Tools

- Pre-Connectathon
- Connectathon
- RTMMS - hRTM

- RTMMS - Nomenclature
- 'DIM Modeling – 'DIM Editor - DeviceEditor'
- ICSGenerator' - sunsetted
- 'ValidatePDU' – on hold

Medical Devices

- Interoperability
- Body Area Network Standards
- Security

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National Cybersecurity Center of Excellence

Healthcare Sector

National Institute of Standards and Technology

August 2019

National Institute of Standards and Technology
U.S. Department of Commerce

Information

NCCoE
NATIONAL CYBERSECURITY
CENTER OF EXCELLENCE

Healthcare Sector

- Projects
  - Securing Telehealth Remote Patient Monitoring Ecosystem Project Description
  - Securing Picture Archiving and Communication Systems Project Description
  - Securing Wireless Infusion Pumps in Healthcare Delivery Organizations (SP 1800-8)
  - Securing Electronic Health Records on Mobile Devices (SP 1800-1)
- Join our Community of Interest
  - Email us at hit_nccoe@nist.gov

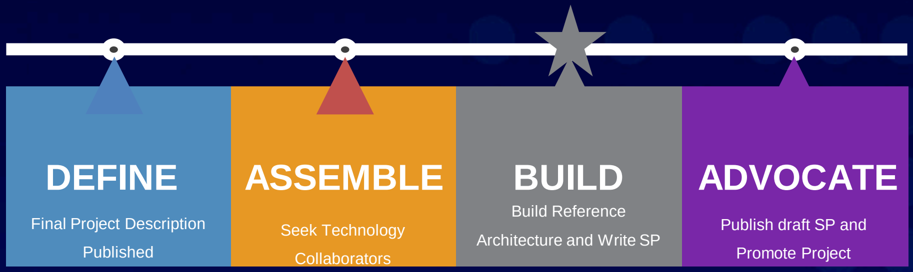
Information Technology Laboratory, National Institute of Standards and Technology

Securing Picture Archiving and Communication System (PACS)

Cybersecurity for the healthcare sector

Overview

- PACS is nearly ubiquitous in hospitals, prompting the Healthcare Sector Community of Interest (COI) to identify securing PACS as a critical need.
- This project will provide a reference architecture and an example solution for demonstrating the capabilities to address the cybersecurity challenges of a PACS ecosystem



Project Status

Build Phase - Currently building example solution in the NCCoE lab and drafting the NIST Special Publication 1800-series Practice Guide with expected publication date of 09/2019/2019

Collaborate with us

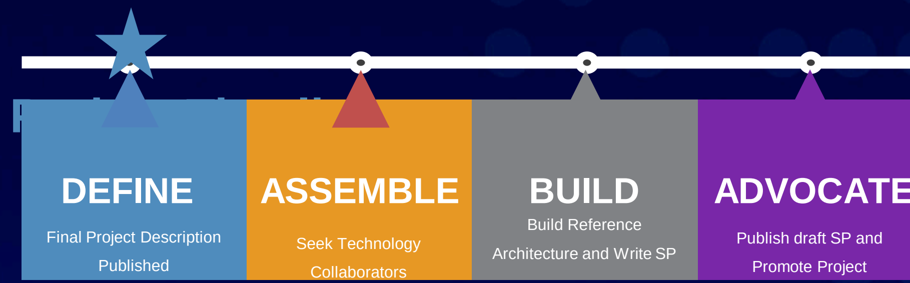
- Read Securing Picture Archiving and Communication (PACS) Project Description
- Email hit_nccoe@nist.gov to join the Community of Interest for healthcare projects

Telehealth Remote Patient Monitoring (RPM)

Cybersecurity for the Healthcare Sector

Overview

- Telehealth is one of the fastest growing sectors within healthcare. It leverages network-connected devices to monitor and treat patients outside of a healthcare delivery organization's (HDOs) closed environment. This project was driven by the NCCoE healthcare Community of Interest (COI) and will demonstrate an example solution with the capabilities to address the cybersecurity challenges of a telehealth RPM ecosystem.



Project Status

- Define Phase –The final project description was published in May 2019. A federal register notice seeking technology collaborators will be published soon.

Learn more:

- Read Securing Telehealth RPM Project Description
- Email HIT_nccoe@nist.gov to join the Community of Interest for healthcare projects

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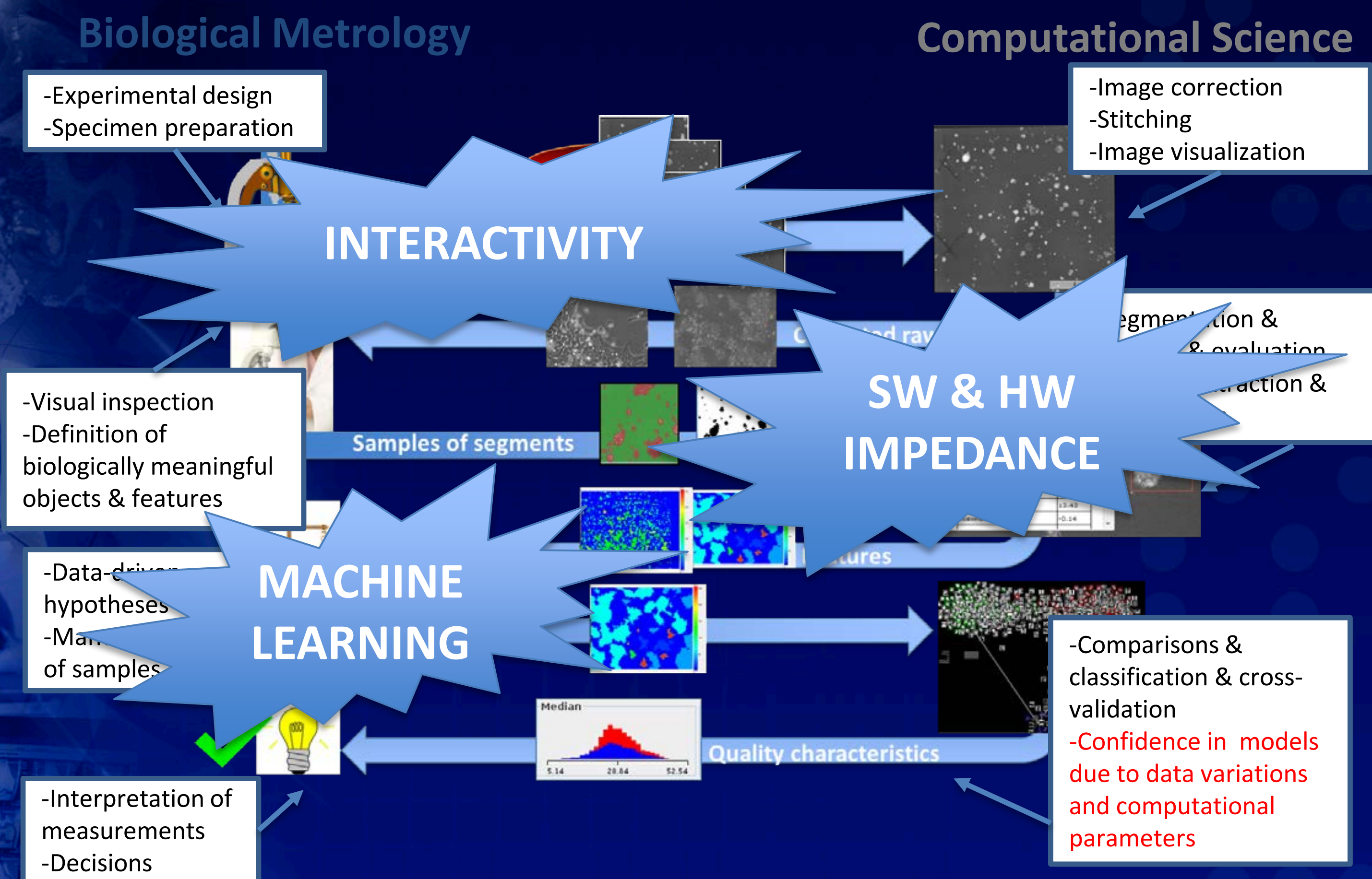
- Summary: Towards Smart Health Care

Medical Imaging

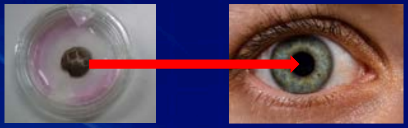
- Change Analysis – Lung Cancer
- NIST/QIBA Activities
- Iterative Reconstruction
- Interpreting Wireless Capsule Endoscopy Images
- From Images to Diagnosis through Ontologies
- Image Quality for Healthcare Applications
- Computational Metrology for Biomedical Imaging
- Performance of Scalabale Systems

Confidence in CS Metrology & Big Data Measurements



Use Case: Age–Related Macular Degeneration (AMD)

- **11 million** affected people in the US. Leading cause of vision loss in adults.
- Estimates of the global cost is **$343 billion**, including **$255 billion** in direct health care costs.
- Stem cell engineering of retinal pigment epithelium to treat macular degeneration (collaboration with NIH)



AMD vision

Stem Cell Therapy + Images → Quality Measurements ✓

20/20 Vision

Use Case: Age–Related Macular Degeneration (AMD)

AMD blurred vision

20/20 Vision

Scale
- Single Microscope FOV (10X) = 0.034% of 10 cm diameter dish ~1 MB

<1 TB image of total dish over time

Complexity
- Phase Contrast
- Fluorescent imaging
- Bright-field imaging

Imaging instruments

Speed
- Identify & count healthy cells/colonies
- Distribution of cells

Therapy Failed

Therapy Worked

Outline

- Healthcare Vision
- Health IT at NIST
- Standards & Testing
- Security
- Biomedical Imaging
- Bioinformatics
- Summary: Towards Smart Health Care

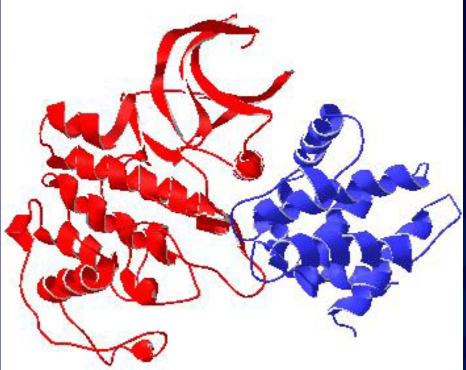
Bioinformatics: Projects

- Cellular Markers that Report Microenvironment
- Dynamic Measurements in Live Cells
- Computational Geometry
- Protein-Protein Interaction Networks
- Precision Medicine
- Performance of Scalabale Systems

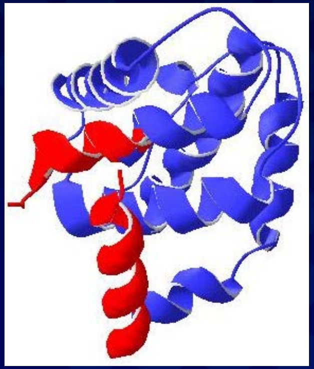
Motivation

- Cyclin-dependent kinase 5 (*Cdk5*) operates in human brain
  - Involved in cell development, cancer and neurodegeneration
- P25 is a pathological cdk5 activator
  - Cdk5/p25 causes phosphorylation of brain protein tau (Alzheimer's disease)
- An experimental study of the effects of truncated fragments of p25 on Cdk5 activity is carried out in the Neurochemistry Lab, NINDS
- Inhibitory fragments inhibit cdk5/p25 pathology, but inhibition mechanisms are unknown
- Small fragments are needed for effective clinical trials
  - No side effects, can cross blood brain barrier

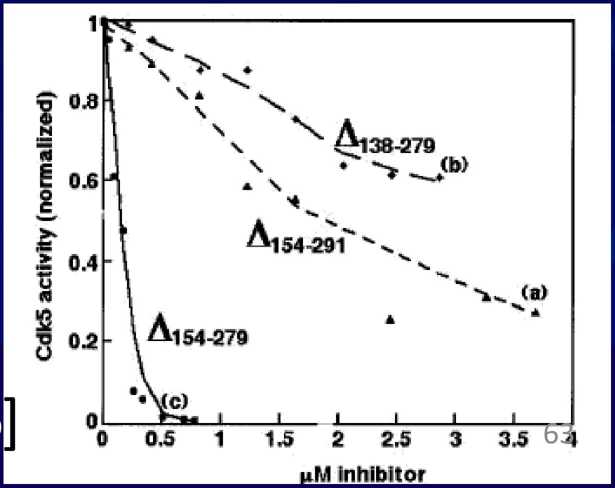
cdk5/p25 complex



Amino acids in red are removed from p25 to obtain CIP



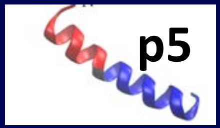
Cdk5 activity .vs. inhibitor concentration

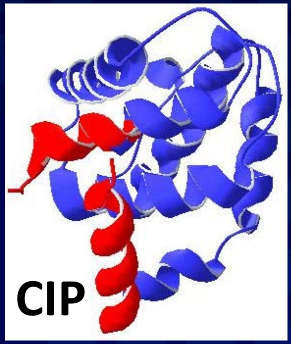


[Amin02]

Problem Formulation

- Fragments are randomly obtained from p25 and tested (years of work)
  - First inhibitor tested, CIP, consisted of 124 amino acids (too big!)
  - Smaller inhibitor tested so far, p5, consists of 24 AAs
    - Can cross the blood brain barrier
    - It is still big, so high probability of side effects





- Computer-based studies should be used to provide insights into Cdk5-inhibitor bindings
  - Binding prediction and simulation
- No more random truncations of p25 fragments, but computer-aided peptide design

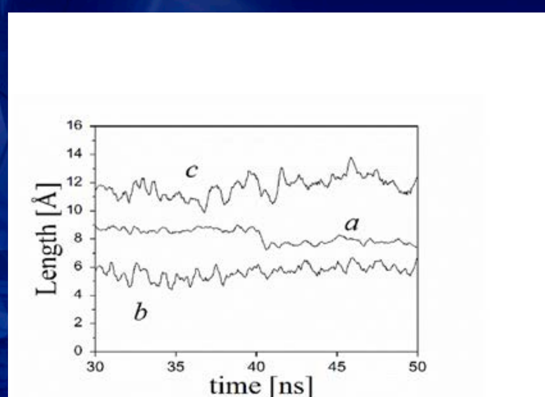
Proposed approach

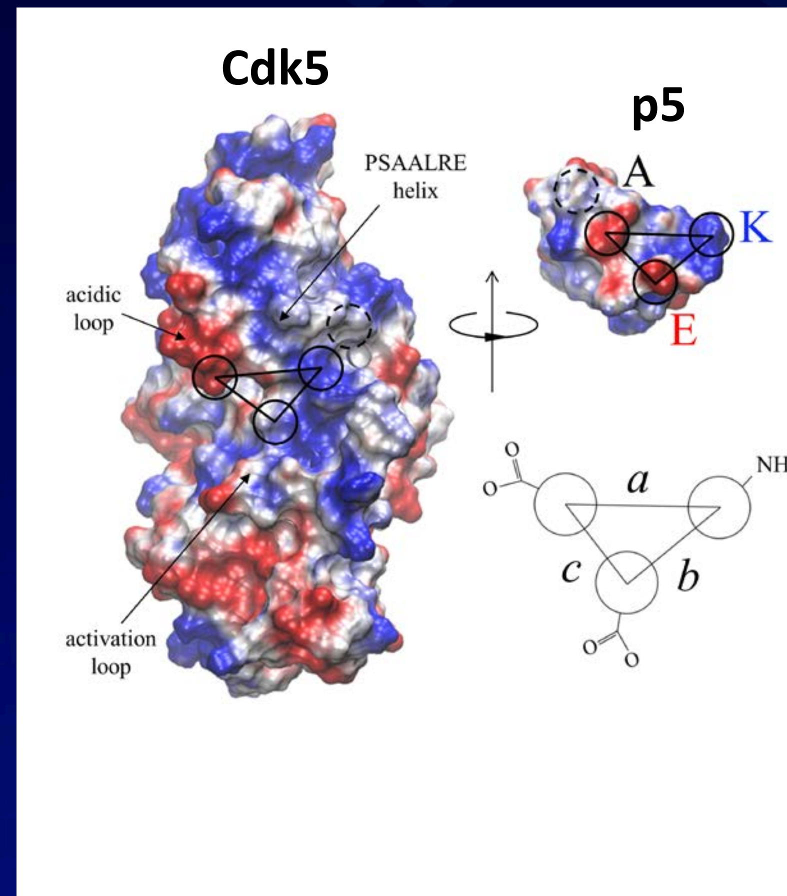
- A method to predict protein-protein association in solution has been defined [1,2]
- Basic idea: in the early stages of complexation, proteins form metastable preferential first-encounter complexes, from which stable binding modes evolve. The main steps are:

1. Protein conformers are obtained using a Monte Carlo (MC) method
2. For each pair of conformers, MC optimizations yield a set of first-encounter modes, defining a probability distribution
3. First-encounter modes are combined into a generalized probability function to simulate protein-protein systems using self-adaptive configurational bias-MC simulations.
4. The binding modes thus obtained are refined using Molecular Dynamics (MD) simulations

Results

- Cdk5-p5 pharmacophore was characterized
  - Strong electrostatic interactions identified
  - Spatial arrangement and critical AAs known
  - Dynamic stability tested





Outline

- Background to NIST
- Healthcare Vision
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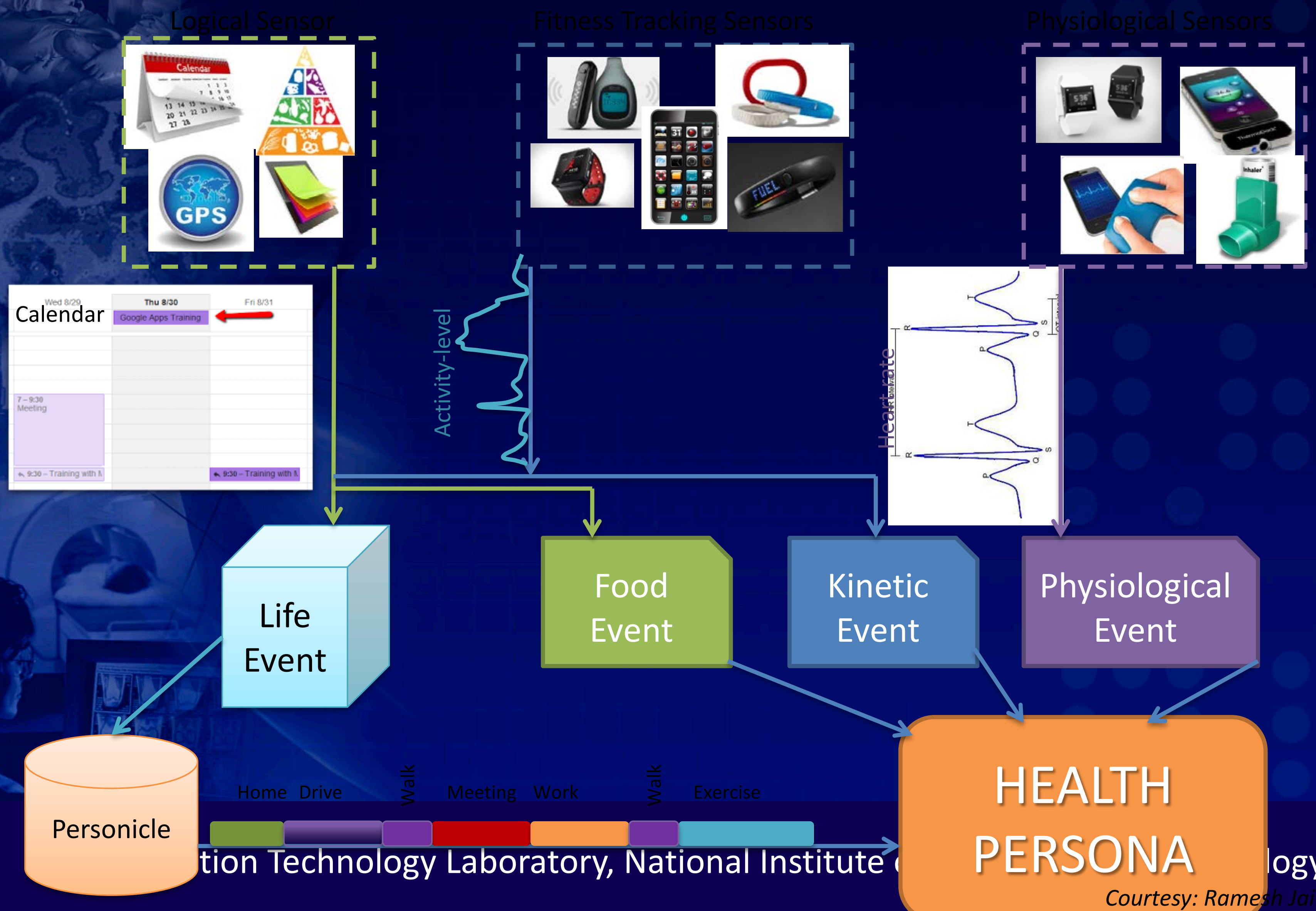
Defining Health Persona



Courtesy: Ramesh Jain, UCI

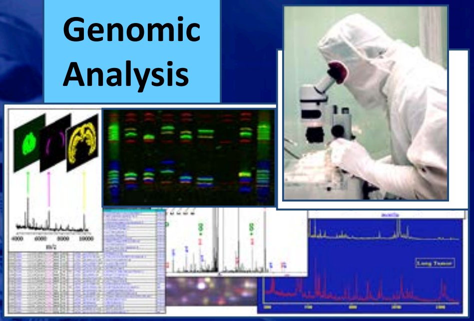
Personal Health Record

Electronic Health Record

Plavix?

CYP2C19

Genomic Analysis



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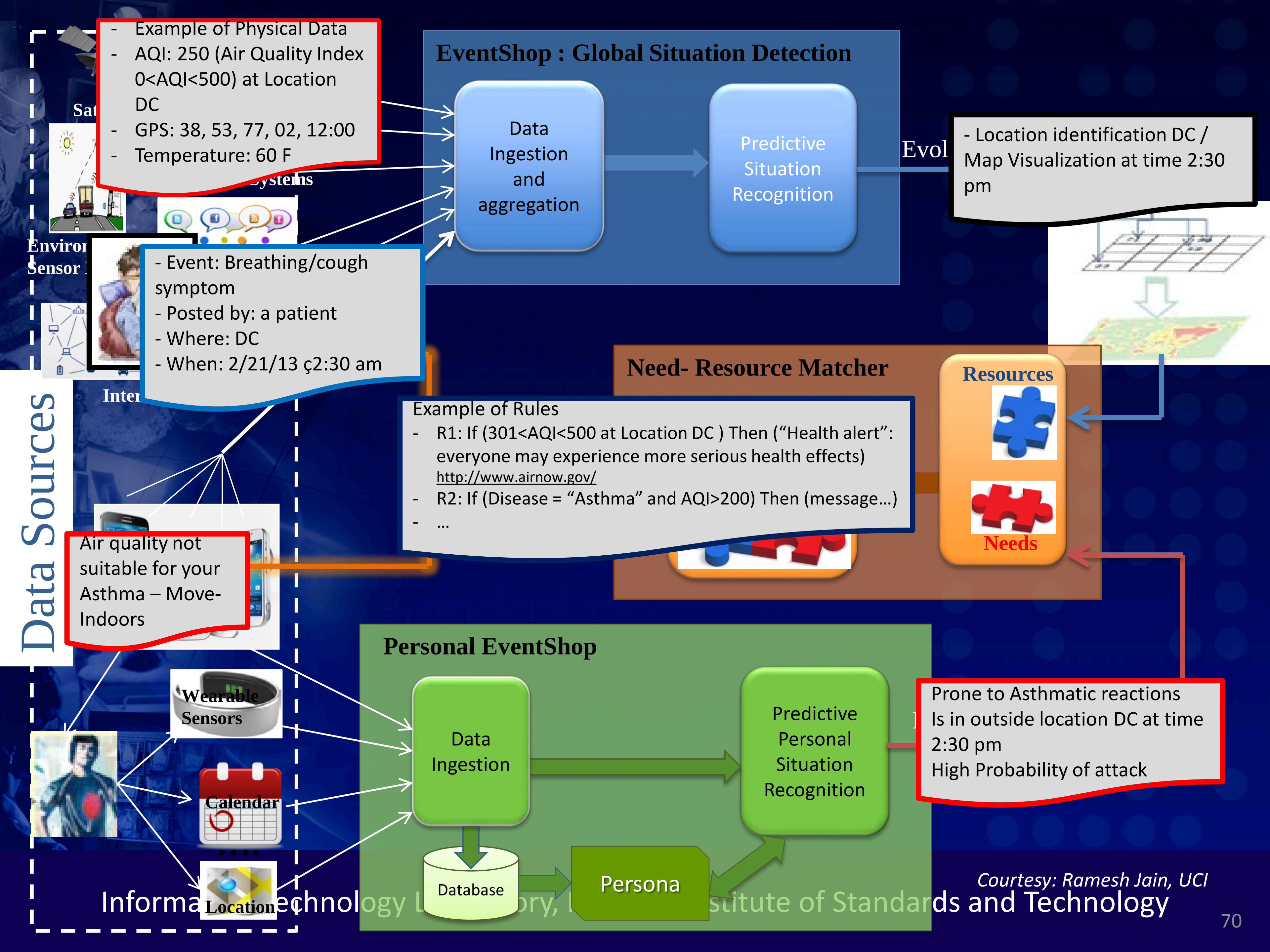
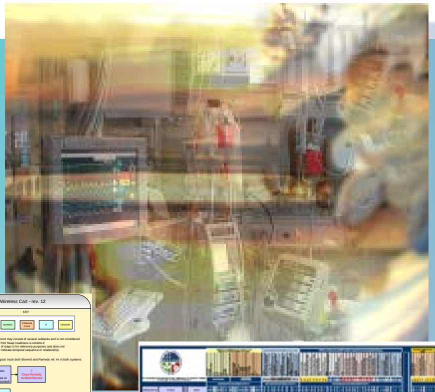
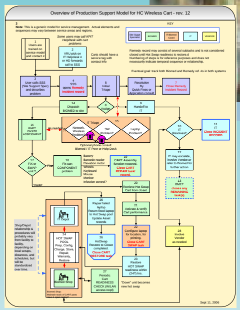
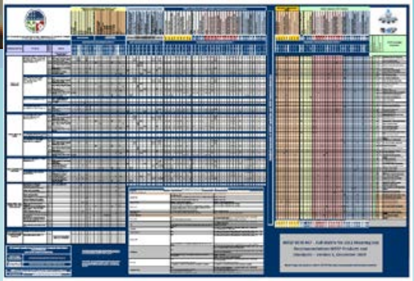
HEALTH PERSONA → PHR


- Example of Physical Data
- AQI: 250 (Air Quality Index 0<AQI<500) at Location DC
- GPS: 38, 53, 77, 02, 12:00
- Temperature: 60 F
EventShop : Global Situation Detection
Data Ingestion and aggregation
Predictive Situation Recognition
- Location identification DC / Map Visualization at time 2:30 pm
- Event: Breathing/cough symptom
- Posted by: a patient
- Where: DC
- When: 2/21/13 ç2:30 am
Need- Resource Matcher
Resources
Needs
Example of Rules
- R1: If (301<AQI<500 at Location DC) Then (“Health alert”: everyone may experience more serious health effects) http://www.airnow.gov/
- R2: If (Disease = “Asthma” and AQI>200) Then (message…)
- …
Data Sources
Air quality not suitable for your Asthma – Move-Indoors
Personal EventShop
Data Ingestion
Predictive Personal Situation Recognition
Database
Persona
Prone to Asthmatic reactions
Is in outside location DC at time 2:30 pm
High Probability of attack
Wearable Sensors
Calendar
Location
Courtesy: Ramesh Jain, UCI







Smart Healthcare

- Smart Devices
- Smart Networks
- Smart Processes
- Smart EMRs
- Smart Medicine
- Smart Organizations
- Smart Collaborations
- Smart Society
- Smart Planet

Courtesy: Fred Hosea, Ph.D.
Program Director
Clinical Technology

fred.w.hosea@kp.org

Smart Doctor

Information Technology Laboratory, National Institute of Standards and Technology

Courtesy: Rod Grupen & Tihomir Latinovic

Summary

- *We develop measurements, tools, and prototypes, and contribute to voluntary standards to advance the use of information technologies in healthcare systems and achieve an interconnected electronic health information infrastructure.*
  - Collaborate with industry to develop clear, testable public specifications
  - Based on industry priority we develop conformance test suites to ensure correct, robust interoperable software
  - Develop prototypes of emerging HC standards to fill in the gaps that are identified by industry
  - Develop the Health IT Testing Infrastructure
  - Research into standards, measurements, and testing methodologies for emerging technologies

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- Smart Health Care: E. Subrahamanian (IPA)
- Collaborators: MML, NIH, UMCP, UMBC, UCI, Etc.

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