

FHIR®[®], Interoperability, and the World of Enablement

W. Ed Hammond. Ph.D., FACMI, FAIMBE, FIMIA, FHL7

Director, Duke Center for Health Informatics. DTMI

Director, Applied Informatics Research, DHTS

Professor, Department of Community and Family Medicine

Professor Emeritus, Department of Biomedical Engineering

Adjunct Professor, Fuqua School of Business

Research Professor, School of Nursing

Duke University

Chair Emeritus, Chair US Realm, Co-chair CIC, HL7

ONC SDC Initiation Coordinator



Nothing to Disclose

Learning Health Systems

- Precision Medicine
- Population Health
- Predictive Analytics
- Big Data
- Registries
- Decision Support and Artificial Intelligence
- Electronic Health Record
- Consumer Involvement



In Lewis Carroll's *Through the Looking-Glass*, Humpty Dumpty discusses **semantics** and **pragmatics** with Alice.

"I don't know what you mean by 'glory,'" Alice said.

Humpty Dumpty smiled contemptuously. "Of course you don't—till I tell you. I meant 'there's a nice knock-down argument for you!'"

"But 'glory' doesn't mean 'a nice knock-down argument'," Alice objected.

"When I use a word," Humpty Dumpty said, in rather a scornful tone, "it means just what I choose it to mean—neither more nor less."

"The question is," said Alice, "whether you can make words mean so many different things."

"The question is," said Humpty Dumpty, "which is to be master—that's all."

Alice was too much puzzled to say anything, so after a minute Humpty Dumpty began again. "They've a temper, some of them—particularly verbs, they're the proudest—adjectives you can do anything with, but not verbs—however, I can manage the whole lot! Impenetrability! That's what I say!"



What do all these words have in common?

- All are included in the concept of a learning health system.
- All require standards to work.
 - Transport of data from sources to users
 - Push use case – defined set
 - Pull use case – on the fly. I want what I want when I want it.



What is a learning health care system?

- The IOM's vision:
 - Research happens closer to clinical practice than in traditional university settings.
 - Scientists, clinicians, and administrators work together.
 - Studies occur in everyday practice settings.
 - Electronic medical records are linked and mined for research.
 - Recognition that clinical and health system data exist for the public good.
- Evidence informs practice and practice informs evidence.



Why we need Learning Health

- Clinicians document what they were taught in medical school.
- Clinicians document only what they want to see at the next visit.
- We think the purpose of the EHR is to document care rather than a basis for continuing care, evaluation, patient safety, and a contribution to new knowledge.
- We still support the concept of secondary uses rather than continuous use.
- We keep our knowledge in our head.



Learning ... what?

- We need to establish the syllabus for learning health.
- How do we learn what do we need to learn?
 - By comparing our outcomes with other institutions
 - By recognizing what does not work as well as it could
 - By recognizing what needs to be changed
 - By recognizing what is better
- When we find a problem and fix it, we need to automate that process so the solution is applied automatically.



Table N

- Modeled after Table 1 from clinicaltrials.gov
- Provides a high level summary of an institution's EHR
- Documents significant performance factors
 - Controlled diabetics
 - Hospital acquired infection
 - Readmission rate
 - Inappropriate use of ER
- Learn who is best and how, then duplicate



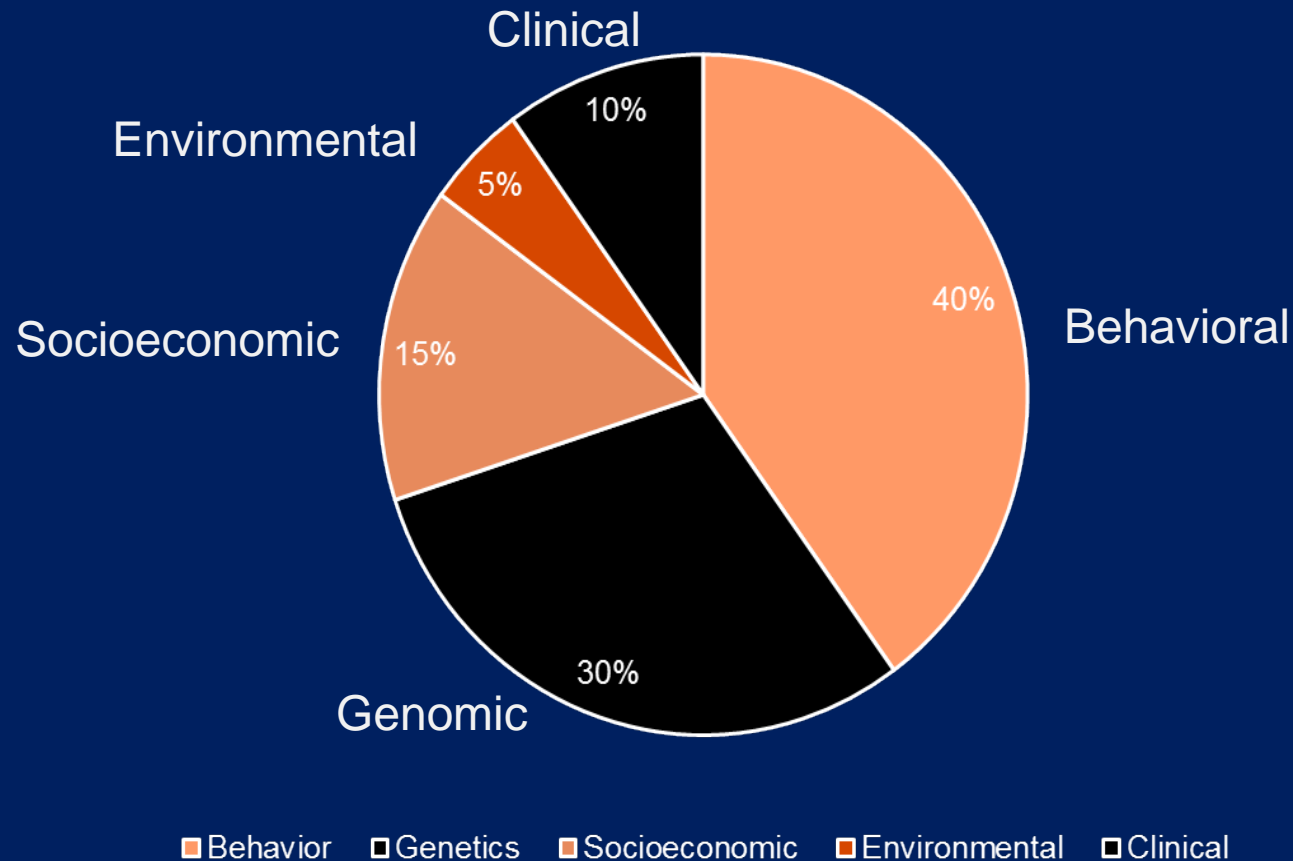
Technology

- Learning Health means keeping up with new technology
 - Recognize change is continuous
 - Design to accommodate change
 - Define what is required and find appropriate technology to achieve.
 - Culture innovation (disruptive) and vision
 - Never except “We don’t do it that way.”
 - Believe anything is possible.
 - Don’t be bound by how we do it today.



Multiple kinds of data

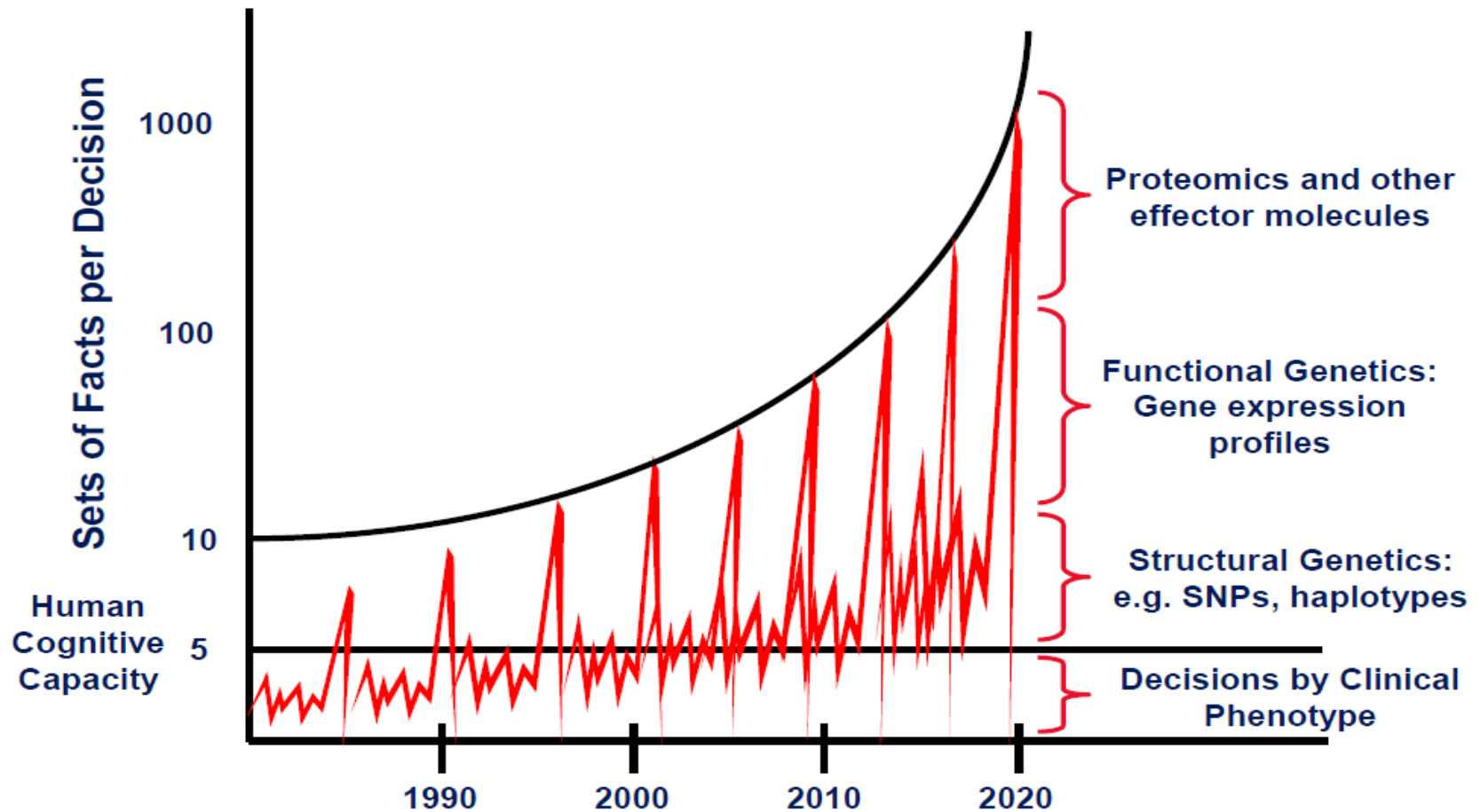
Health Indicators



Source: McGinnis JM, Williams-Russo P, Knickman JR. The case for more active policy attention to health promotion. Health Aff. (Millwood) 2002;21: 78-93



Burning Platform: Overwhelming Complexity



Stead WW. Beyond expert-based practice. IOM (Institute of Medicine). Evidence-based medicine and the changing nature of health care: 2007 IOM annual meeting summary.(Introduction and Overview, p. 19). Washington, DC: The National Academies Press 2008.

Recalibrating Informatic's "True North" | William W. Stead | May 27, 2010 | 2010 AMIA NOW!



Artificial Intelligence

- Knowledge exceeds the ability of humans to use available facts to make decisions
- Computers are becoming able to learn from data and knowledge that is available on the internet and other sources. Computers are becoming self-aware. Create new knowledge.
- Increase the use of decision support algorithms.
- Reevaluate the complete status of a patient with every new set of data entered into the EHR.



Registries

- Tool for Learning Health
- Permits management of disease and patients
- Permits evaluation and comparison
- Highlights performance
- Types of registries
 - Patients
 - Chronic Disease
 - Rare disease
 - Implantable devices
 - Communities



Embracing Learning Health

- Be willing to change the way you do things.
- Rethink boundaries.
- Remove silos.
- Share ideas, methods, credit
- Create new working relationships
- Translational medicine is what it's all about.
- Quality and trust is mandatory.



Embracing Learning Health

- Be willing to change the way you do things.
- Rethink boundaries.
- Remove silos.
- Share ideas, methods, credit
- Create new working relationships
- Translational medicine is what it's all about.
- Quality and trust is mandatory.



What is LHS?

- Learn and use from the Best of the Best
- Shorter time from research to routine use
- Fewer medical errors
- Fewer missed diagnoses
- Earlier diagnoses
- Consistency
- Better outcomes



What standards are required to support Learning Health Systems and related functionalities?



Functionality required

- Aggregation of data across multiple sources
- Aggregation of data across a variety of EHR systems
- Accommodate a variety of sources of data
- Incorporation of a variety of terminologies
- Creation and management of registries
- Bringing together a variety of stakeholders who have different requirements and different motivations



Barriers that must be overcome

- Patient identity across multiple heterogeneous databases
- Accommodating large and small healthcare settings
- Accommodating a variety of clinical settings – inpatient, outpatient, ...
- Create both public and private partnerships
- Governments at city, county, state and national levels



More barriers

- Semantic interoperability !!!!!
- Create business case that demonstrate true value to all participants
- Resolving privacy issues, yet uniquely identify persons to permit constructive interventions



What FHIR offers

- Faster to learn and implement and trouble shoot
- Lower cost to learn and implement
- Scales well from simple to complex
- Flexible
- Free and fully open
- Uses modern technologies



What do we really want?

- In the simplest of terms, we want to exchange data between disparate sites
 - Predefined trigger and content
 - Content specified through a query
- We want the receiver to understand and use the data exchanged



And along came FHIR

- F – Fast (to design & to implement)
- H – Health
- I – Interoperable
- R – Resources (Building blocks)

- “FHIR” (pronounced “Fire”) is a fertile source of puns etc.



What is FHIR?

- Based on a set of modular components called “Resources”
 - Resources refer to each other using URLs
- Resources are combined into “Profiles” to solve clinical and administrative problems in a practical way.
- Exchange resources between systems
 - Using a RESTful API (e.g. web approach)
 - As a Bundle of resources (messages, documents)
- FHIR was influenced by the JASON Report which was published about the time the concepts behind FHIR were being defined.



What problems does FHIR solve?

- FHIR is service-driven.
- That means you can send just the data that is required for a specific purpose.
- FHIR permits transporting data at the lowest levels of granularity or at any level of packaged data.



FHIR Design philosophy

- Focus is on implementers – plenty of tools, lots of examples, many APIs available
- Targets support common scenarios
- Uses the same cross-industry technologies as Google, Facebook, others
 - XML, JSON, HTTPS, OAuth
- Supports human readability as basic level of Interoperability
- Supports multiple paradigms & architectures



Resource Based

- Things vs actions
- Nouns vs verbs
- REST vs SOAP – RPC
- Identified by URIs



Resources

- Small logically discrete units of exchange defined behavior and meaning
- Have known identity and location
- Currently over 150 different resources that are intended to cover all of healthcare.
- Examples include Patient, Practitioner, Allergy Intolerance, Family History, and Care Plan.



Resources consist of 3 parts

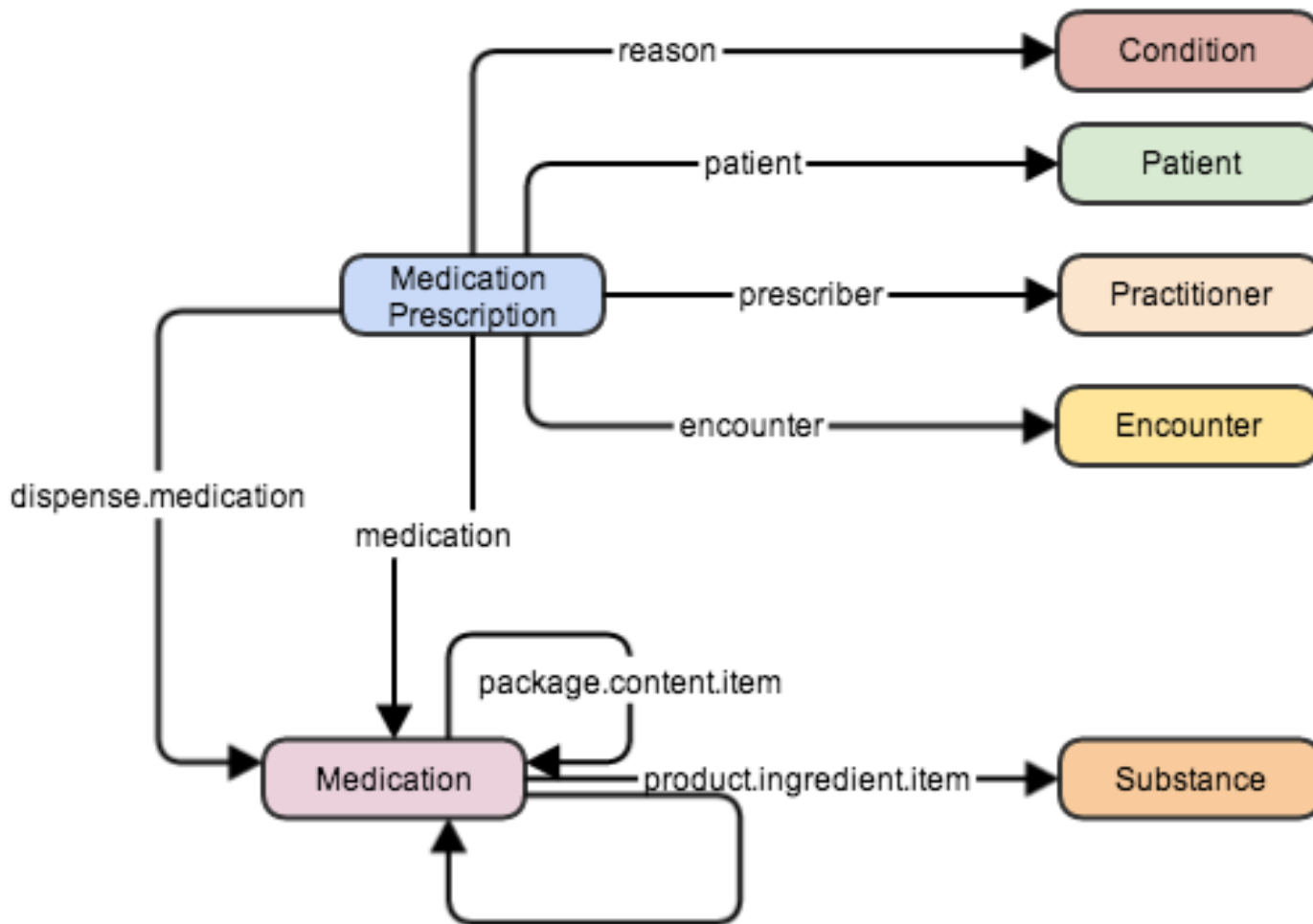
- Structured data – attributes to support 80% common use cases. Other content are pushed to something called extensions.
- Narrative – textual summary of the content of the resource.
- Extensions – attributes to support non-common use cases.
- Resource identity [URI] is, in fact, a URL.



References

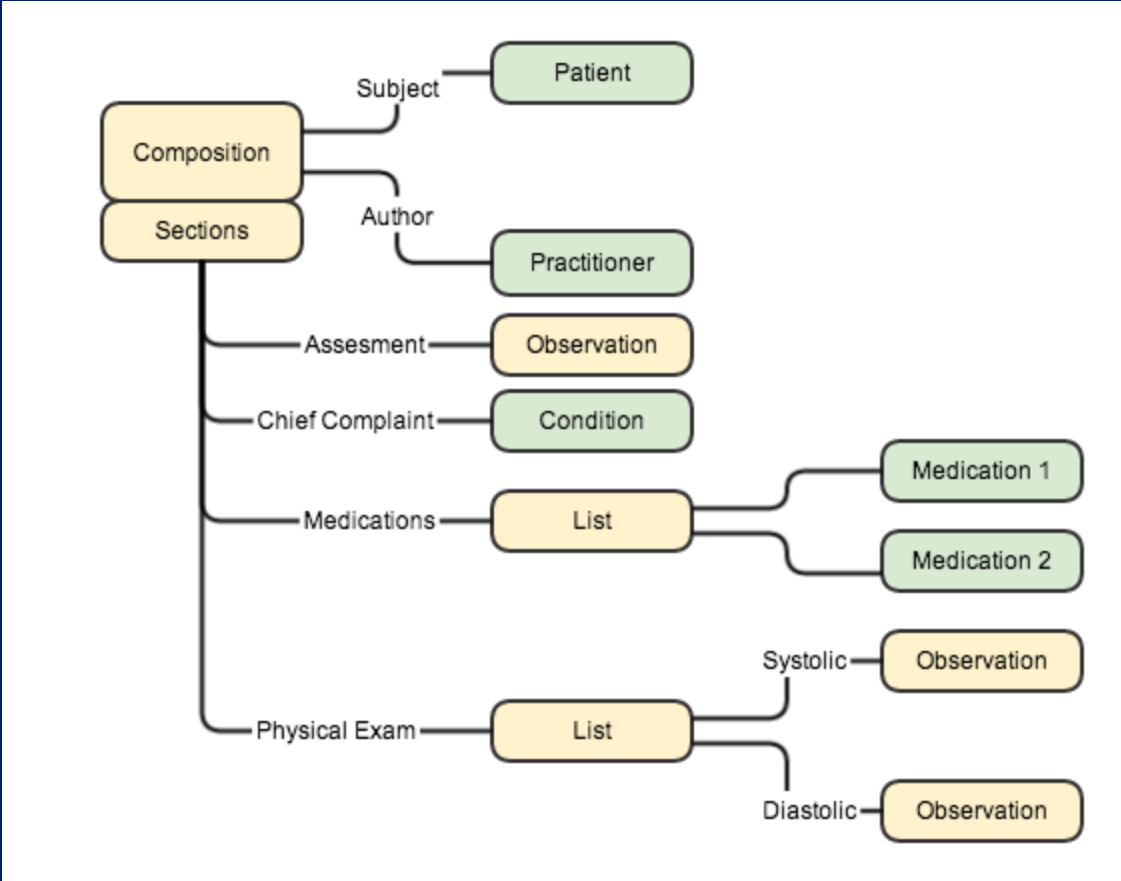
- Links from one resource to another.
- References combine to create a network of data that represent a specific component or subject area of the EHR.
- Systems are designed to navigate the links to decide what resources they need for a given task.





Source: HL7 International

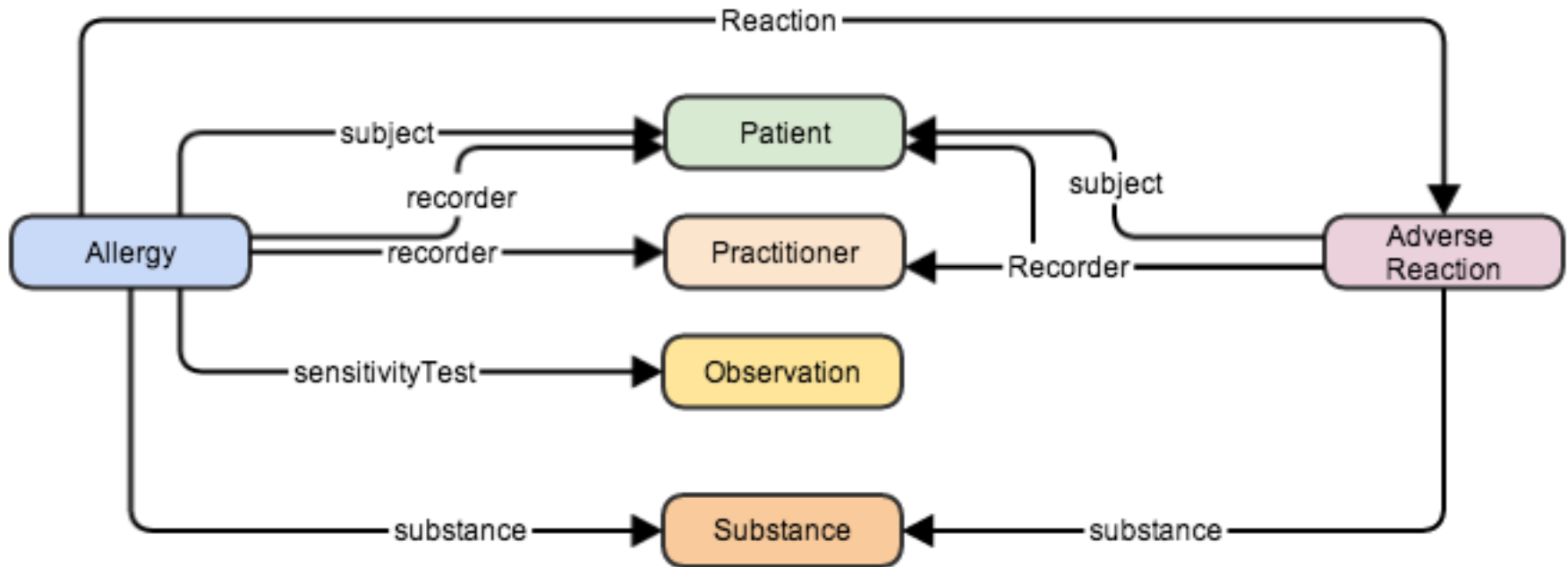




Source: HL7 International



References between resources



Source: HL7 International



PROFILES

- Parties exchanging data define the specific way they want to use resources and their relations using Profiles.
- Profiles are the framework for defining services.
- Profiles define what a particular application needs to communicate based on Resources and Extensions.



Examples of Profiles

- For referral of a patient to another facility.
- For populating registries.
- For supporting a HIE.
- Adverse event reporting
- Ordering a medication.
- Providing data to a clinical decision support algorithm such as a risk assessment calculation



How Resources are exchanged

- RESTful API
- Search/Query
- Documents or Forms
- Messaging
- Services (SOA)



Representational state transfer (REST)

- REST is a software architectural style for how to connect systems consisting of guidelines and best practices for creating scalable web services
- RESTful systems typically communicate over HTTP verbs (GET, POST, PUT, DELETE, etc.)



REST

- Outcomes
 - Simple stable interfaces
 - High Performance / Scalability
 - Visible Process (e.g. can debug)
 - Portability
 - Reliability (resistance to failure)



Architectural Constraints

- Client-server
- Stateless
- Cacheable
- Layered system
- Code on demand
- Uniform interface



REST Operations [CRUD(E)]

- Create – create a new instance of data
- Read – get the content (state) of an instance of data
- Update – change the content of an instance of data
- Delete – remove the instance of data
- Execute – get the instance of data (?) to do something for you



Advantages

- Simplicity of interfaces
- Modify components to meet changing needs
- Visibility of communication between components by service agents
- Portability of components by moving program code with the data
- Highly reliable



REST in practice

- “Resources” with an explicit and stable URI
 - The name for what gets exchanged in REST
 - Defined behaviour and meaning
 - Known identity / location
 - Quite an abstract idea
- Formats: XML / JSON (+RDF, coming)
- Exchange using HTTP (Security: SSL / OAuth)
- Often “REST” is followed loosely, hence “RESTful”



Service Oriented Architecture (SOA)

- Do whatever you like
 - (based on SOA principles)
 - Ultra simple workflows
 - Ultra complex workflows
 - Individual resources or collections (in Atom or other formats)
 - Use HTTP or use something else
 - Only constraint is that you're passing around FHIR resources in some shape or manner



OAuth

- Open standard for authentication
- Specifies a process for resource owners to to authorize 3rd-party access to services resources without sharing their credentials.
- Works with HTTP
- Commonly used with Microsoft, Google, Facebook, Twitter



Paradigms

- Regardless of paradigm **the content is the same**
- This means it's straight-forward to share content across paradigms
 - E.g. Receive a lab result in a message. Package it in a discharge summary document
- It also means constraints can be shared across paradigms
 - E.g. Define a profile for Blood Pressure and use it on resources in messages, documents, REST and services



Current Status of FHIR

- Existing Balloted Version of FHIR is Draft Standard for Trial Use (DSTU) V1.0. Date: January 2014.
- DSTU V2.0 was balloted in May 2015. Over 1500 comments were returned and must be reconciled.
- Publication date originally scheduled for September 2015, but now is open (Likely end of October).
- DSTU V3.0 is anticipated to begin immediately after DSTU 2.0 is published.
- Normative version of FHIR is anticipated in 2017.



Connectathons

- Open invitation to any interested party to come and write software that exchanges FHIR resources
- Always hold one before HL7 meetings
 - Next is October 2 in Atlanta + others by invitation
- Mix of skills
 - Newbies (“where is the spec?”)
 - Old hands who’ve been to every connectathon
 - Experiment with new features
- We have a virtual connectathon all the time...



Argonaut

- A collaborative group of organizations that have contributed \$50,000 annually to support and accelerate the development of FHIR.
- Supporting the development of FHIR-based APIs and OAuth-based security in healthcare industry.
- Creating server that supports reading and searching patients

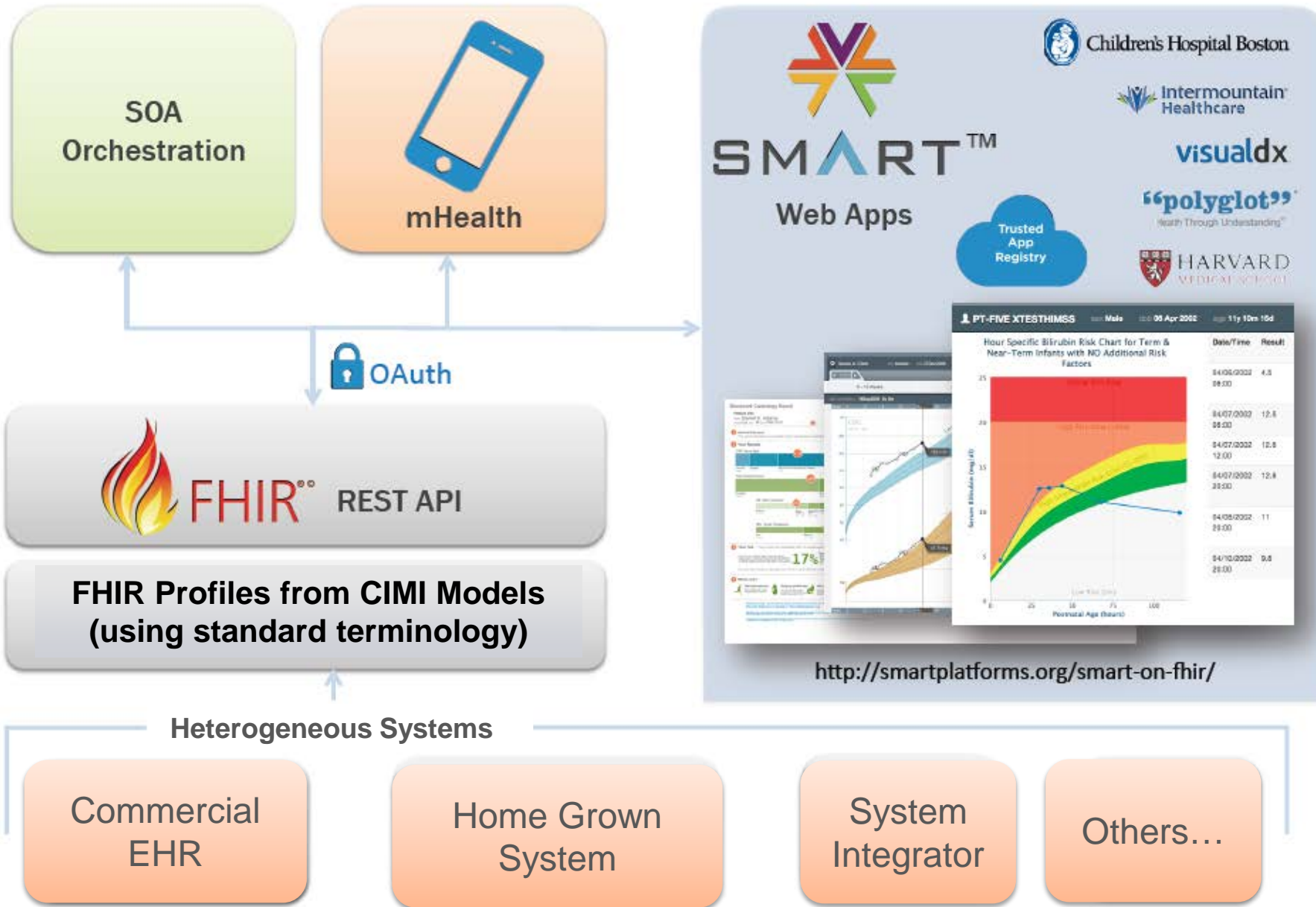


Related Activities

- Data Access Framework – ONC
- Structured Data Capture – ONC
- Quality Improvement Core Profiled
- EHRS Functional model – Record Lifecycle Events
- US Laboratory Guides – reporting lab values to Public Health



SMART on FHIR® – Open Platform Architecture



The Future

- Dominance of Smart Phones as primary communication device
- Service-driven functionalities
- Apps that ...
 - Address specific focused problems
 - Enable data sharing
 - Empower patients/consumers
- Increased use of CDS and AI

