# Smart on FHIR enables Innovative Solutions

APEHC

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# Origin of FHIR: the state of Healthcare

- Health care has broken processes
- Other industries are being transformed
  - IT enables process transformation
- “Patient Centered Ecosystem” is happening very slowly in healthcare
  - IT standards to integrate B2B and C2B do not exist
  - IT is not properly implemented
  - There are many other blockers (culture, business process, liability, regulation)
  - Innovation is *hard* work – network problem

# FHIR: The web, for Healthcare

## Open Community

- Make it easier to exchange healthcare information
- Open Participation - uses web infrastructure (social media)
- Lead by HL7 - deeply connected to world wide health community

## Open Standard

- Describes how to exchange healthcare information
- Public Domain (http://hl7.org/fhir)
- A web API - web standards where possible
- Continuity with existing healthcare standards

# FHIR: Healthcare API

- “Application Programming Interface”: A list of operations that other programs can use
- Web APIs: operations offered using web technologies, work remotely across the internet (or locally)
- FHIR offers healthcare services:
  - What are the patient details?
  - Fetch Laboratory reports for a patient
  - Prescribe a medication for the patient
  - Suggest a treatment option for a patient based on diagnostic reports
  - etc

# Freely available

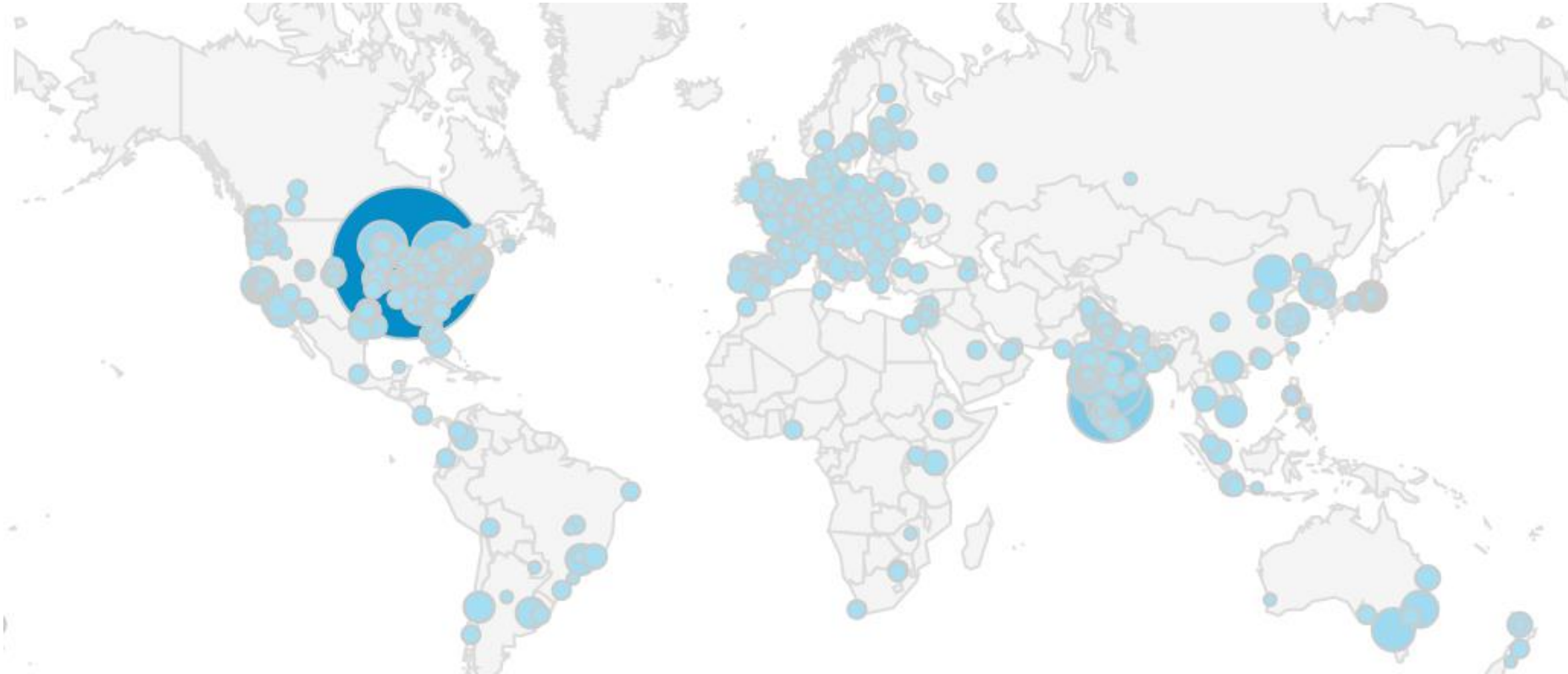
- Known address: http://hl7.org/fhir
- License: Creative Commons Public Domain (CC0):
  - “No Rights Reserved”
  - You can copy, modify, distribute and perform the work, even for commercial purposes, all without asking permission
  - The most open of open licenses
- Anyone can do anything with the content
  - There can be no disputes about ownership of rights to do anything with the FHIR content - HL7 waived its rights
  - HL7 Does protect the trademark / logo

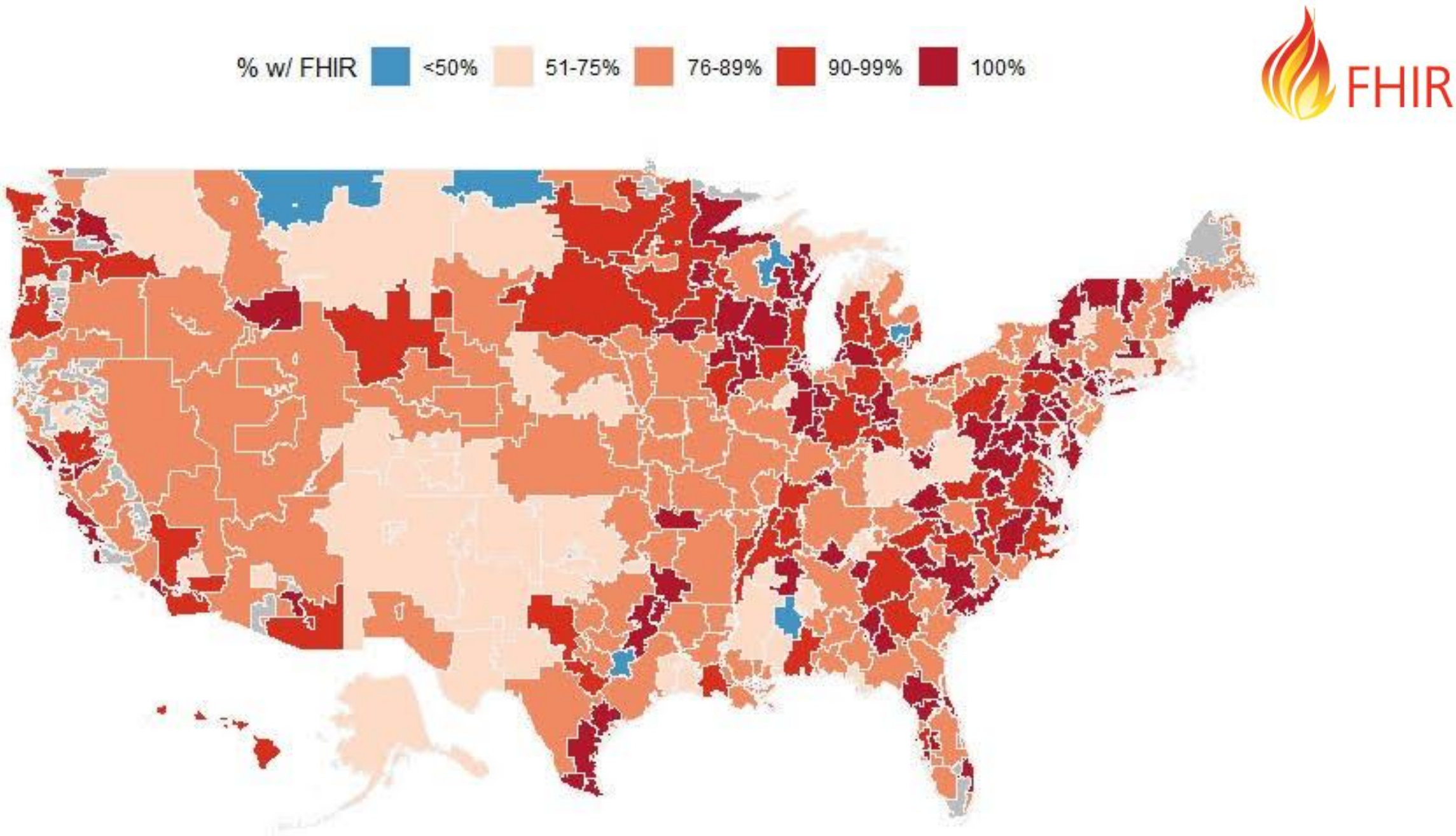
# About HL7

- HL7 = Health Level 7
  - 7 = Obscure reference to obsolete network model: application exchange
- HL7 publishes Health care data exchange standards
  - V2 : healthcare messaging (“HL7”) – widely adopted
  - V3 : healthcare exchange modelling framework – not much adopted
  - CDA : Clinical Document Framework (MyHR, others)
  - FHIR : API for Healthcare data exchange, based on current technology
  - CCOW, CQL, Arden Syntax, others

# Building on the Idea

- A small passionate community rapidly grew around the idea
- Built specification, tools, demonstrations, web presence
- Took some exemplars into production
- Over time, community matured, governance stabilised & reconciled
- Selected by Argonaut (US EHR vendors) + Apple for C2B use
  - various national uses (e.g. English NHS)
- More pilots, more success around the world
- Rapid growth in community – meetings, social media,




% w/ FHIR
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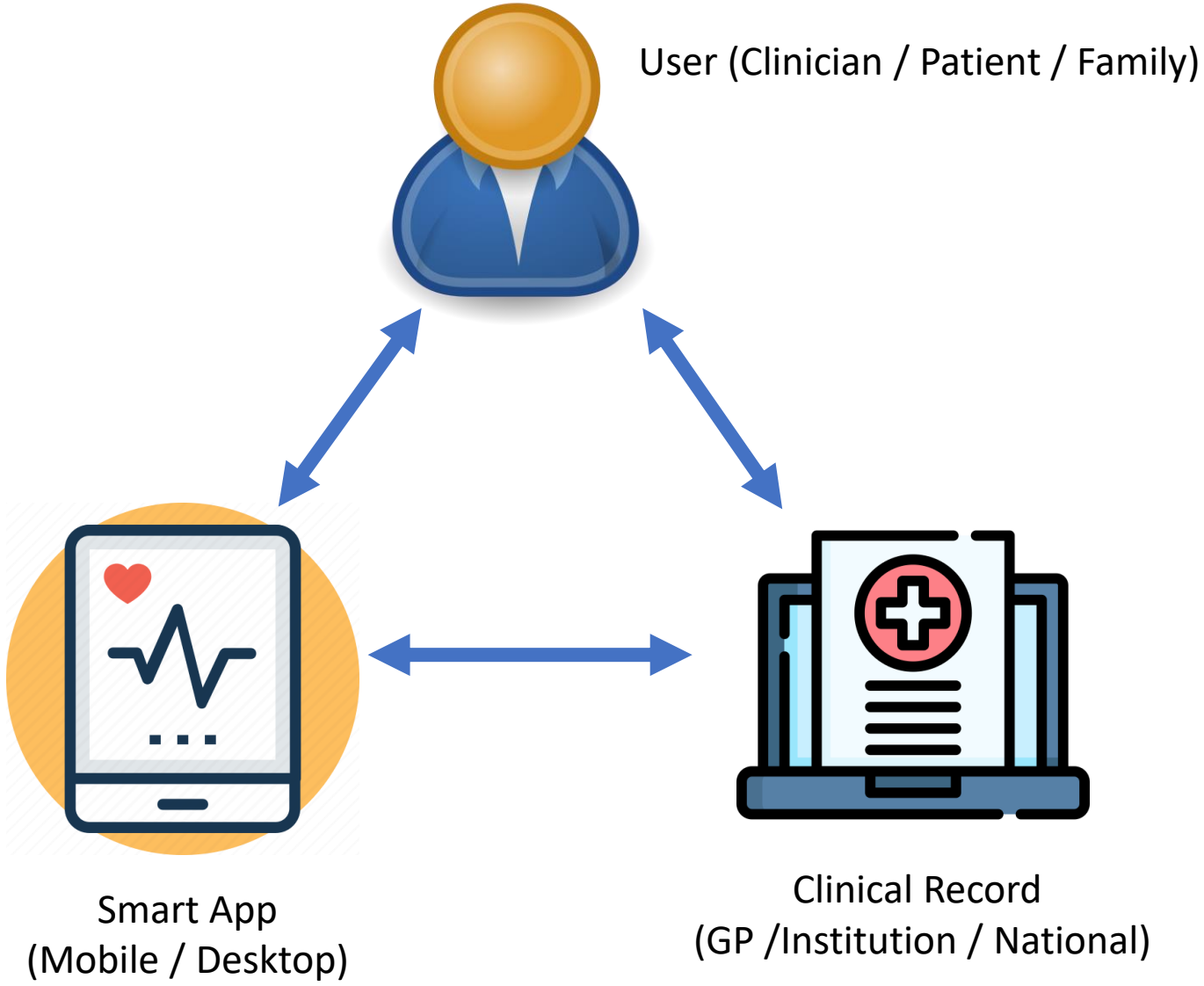
51-75%
76-89%
90-99%
100%

# Why SMART?

- Major Problem: Clinical record systems (LIS / EHR) have massive amounts of data
- All sorts of interesting clinical / business rules could help
- Vendors can’t do everything
- So:
  - Provide a General Purpose API that allows access to EHR data and services
  - With Integrated security
  - And a way to launch application in a child window

# SMART: Substitutable Medical Apps, Reusable Technology

- FHIR – Access Clinical Data & services (IPS/CDI)
- OAuth – Identify User & Get permission
- Clinical Context – Integrate workflow and presentation



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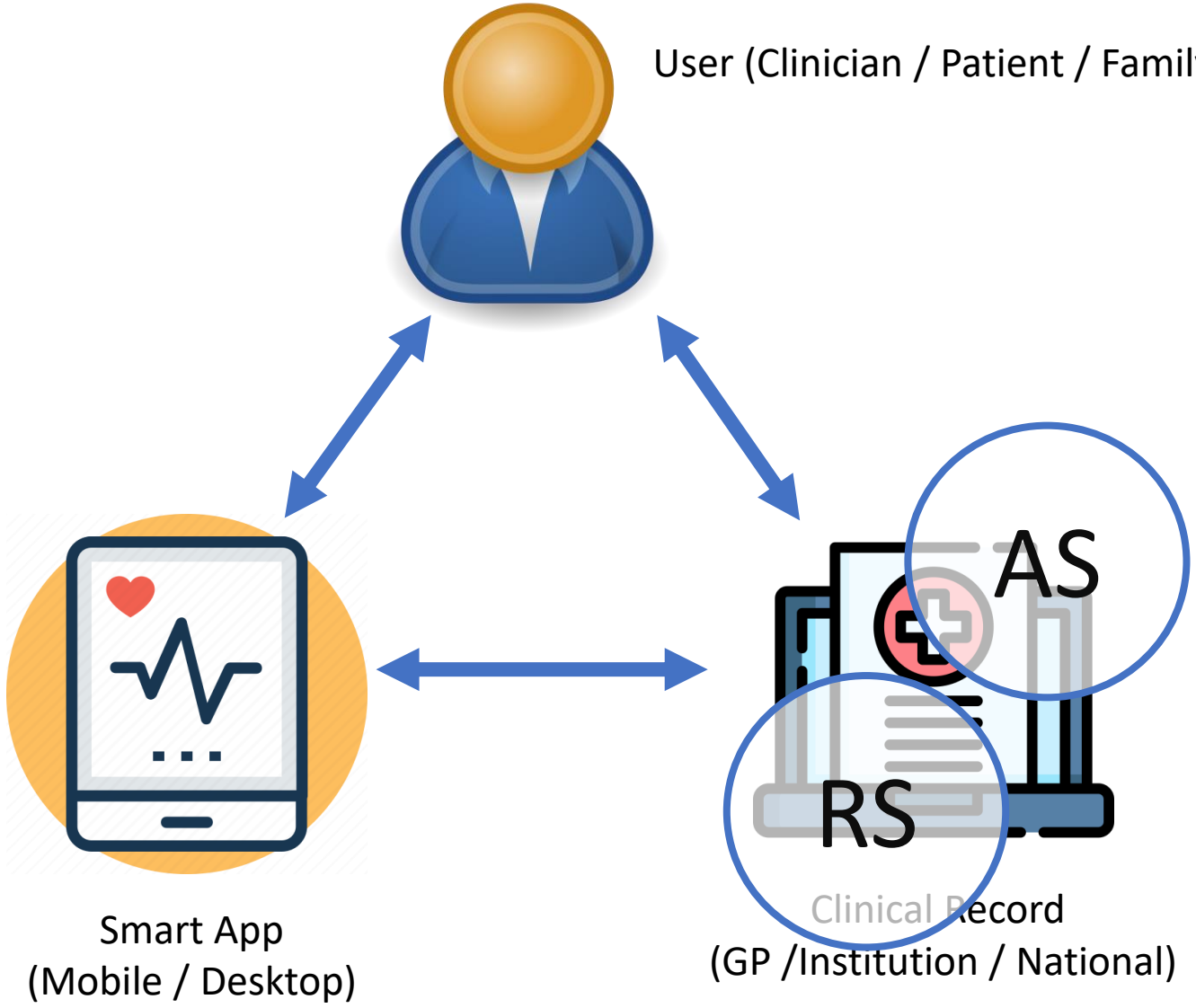
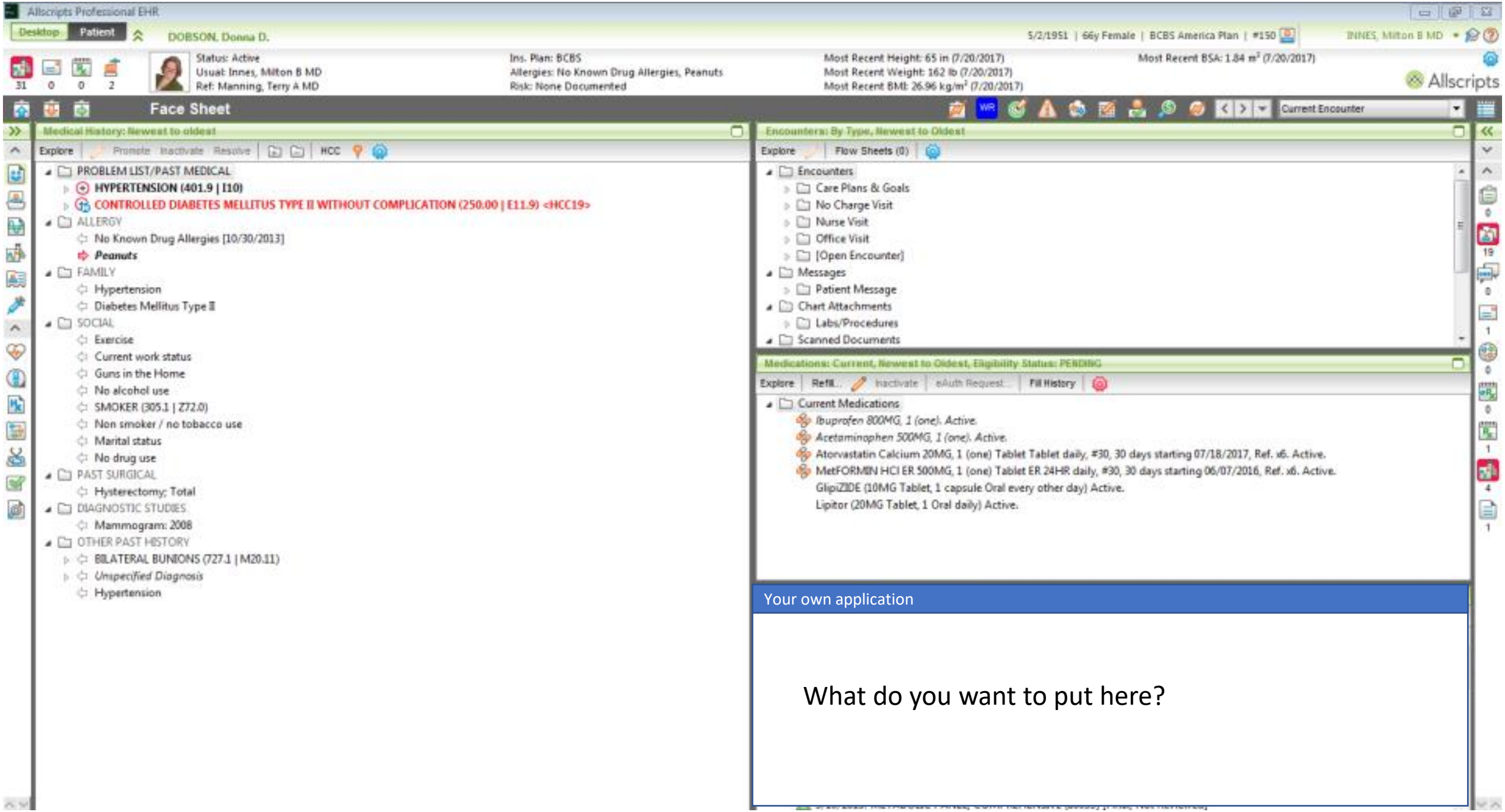



Allscripts Professional EHR
Desktop
Patient
DOBSON, Donna D.
5/2/1951 | 66y Female | BCBS America Plan | #150
INNES, Milton B MD
Status: Active
Usual: Innes, Milton B MD
Ref: Manning, Terry A MD
Ins. Plan: BCBS
Allergies: No Known Drug Allergies, Peanuts
Risk: None Documented
Most Recent Height: 65 in (7/20/2017)
Most Recent Weight: 162 lb (7/20/2017)
Most Recent BMI: 26.96 kg/m² (7/20/2017)
Most Recent BSA: 1.84 m² (7/20/2017)
Allscripts
Face Sheet
Current Encounter
Medical History: Newest to oldest
Explore
Prompts
Inactivate
Resolve
HCC
PROBLEM LIST/PAST MEDICAL
HYPERTENSION (401.9 | I10)
CONTROLLED DIABETES MELLITUS TYPE II WITHOUT COMPLICATION (250.00 | E11.9) <HCC19>
ALLERGY
No Known Drug Allergies [10/30/2013]
Peanuts
FAMILY
Hypertension
Diabetes Mellitus Type II
SOCIAL
Exercise
Current work status
Guns in the Home
No alcohol use
SMOKER (305.1 | Z72.0)
Non smoker / no tobacco use
Marital status
No drug use
PAST SURGICAL
Hysterectomy: Total
DIAGNOSTIC STUDIES
Mammogram: 2008
OTHER PAST HISTORY
BILATERAL BUNIONS (727.1 | M20.11)
Unspecified Diagnosis
Hypertension
Encounters: By Type, Newest to Oldest
Explore
Flow Sheets (0)
Encounters
Care Plans & Goals
No Charge Visit
Nurse Visit
Office Visit
[Open Encounter]
Messages
Patient Message
Chart Attachments
Labs/Procedures
Scanned Documents
Medications: Current, Newest to Oldest, Eligibility Status: PENDING
Explore
Refill...
Inactivate
eAuth Request...
Fill History
Current Medications
Ibuprofen 800MG, 1 (one). Active.
Acetaminophen 500MG, 1 (one). Active.
Atorvastatin Calcium 20MG, 1 (one) Tablet Tablet daily, #30, 30 days starting 07/18/2017, Ref. x6. Active.
MetFORMIN HCl ER 500MG, 1 (one) Tablet ER 24HR daily, #30, 30 days starting 06/07/2016, Ref. x6. Active.
GlipiZIDE (10MG Tablet, 1 capsule Oral every other day) Active.
Lipitor (20MG Tablet, 1 Oral daily) Active.
Your own application
What do you want to put here?

# Extensible Clinical Record Systems

- Launch apps that can access patient record
- Add a way to inject ‘suggestions’ into the application
  - E.g. what things could/should you do for this patient?
- Write your own surveillance/management tools
- Examples in production:
  - Custom advanced dosing regimes (‘DoseMe’)
  - Risk calculators (by many clinical risk ratings)
  - Case Registration applications
  - Apple Health (/Personal Health access)

Smart, Joe
Allergies: Allergies Not Recorded
Care Team: View Details

DOB:05/21/1988 | Age:33 years | Sex:Male | MRN:00490082237
Dose Wt:85.000 kg (08/04/2020) | Advance Directive:Yes | Code Status:<No Data Available> | Isolation:<No Data Available>
HealtheLife:No | Clinical Trial:<No Data Available> | Loc:NU05 | Inpatient FIN: 00098353786[Admit Dt:8/3/2020 1:26:00 AM CDT Di...



Pharmacist Workflow
MAR Summary
Perioperative View
MAR
Orders + Add
Medication List + Add
Allergies + Add
Documentation + Add
Form Browser
Results Review
Interactive View and I&O
Activities and Interventions
Diagnoses and Problems
Patient Information
Oncology
Flowsheet
Medication Request
Chemotherapy Dosing
Multi-Disciplinary Rounding
SMART App Validator
DoseMeRX

## Individualized Dose

2000 mg over 3.5 hours every 12 hours for 2 days

**Target:** AUC24: 450 mg.h/L
**Predicted:** AUC24: 437 mg.h/L

| | |
|---|---|
| Peak | 27.18 mg/l |
| Trough | 10.7 mg/l |
| AUC24 | 437 mg.h/L |

Plot Select

## Guideline Dose*

1500 mg over 2.5 hours every 12 hours for 3 doses

** Non-severe Infection*

| | |
|---|---|
| Peak | 21.49 mg/l |
| Trough | 7.58 mg/l |
| AUC24 | 328 mg.h/L |

Plot Select

## Label Dose

1000 mg over 2 hours every 12 hours for one day

| | |
|---|---|
| Peak | 15.24 mg/l |
| Trough | 5.09 mg/l |
| AUC24 | 227 mg.h/L |

Plot Select

## Customize

Target | Dose

**Target** AUC24

**AUC24** 450 mg.h/L

**Infusion Length** 3.5 hours

**Dosing Interval** 12 hours

**Number of Doses** 4

Calculate

## Individualized Dose Profile

# Case Study: Personal Health Records

- 2010: the year of personal health records
- Each repository / clinical service cost $$$:
  - Marketing, Sales
  - Contact Negotiations / Legal Fees
  - Development / testing / deployment
  - Maintenance, trouble shooting
- TCO: ~$150k (US)

# Case Study: Argonaut

- Government instigated project involving US EHR vendors
  - Vendors ran their own project
- Goal: define a public API for patients to get their own data
  - Secondary goal: use the same API for application extensibility
- Outcome: an industry specification for letting the patient get their healthcare summary –
  - Medications, Allergies
  - Labs, Vital Signs
  - Documents (/ Clinical Notes)
  - All done securely  via SMART on FHIR

# Case Study: Apple Healthkit

- Apple Healthkit uses Argonaut specification (US Only)
- Hospitals can register with Apple for free
- Hospitals get software with the capability for free
- Register with Apple for free
- Have to pass the Apple testing process (some weeks work)
- Have to maintain patient portal accounts

- Reduction in cost for PHR: >90% - it's a commodity

# Smart Launch Sequence #1: Embedded

- EHR is configured to use a Smart Application (web/mobile)
- Creates a contained browser window. Sends browser to Application with a ‘Launch Context’
- Application loads, and then sends browser to auth endpoint
- User discusses the request for access with the Auth server
- Auth server redirects to app with “auth” token
- App converts token to Access token
- App makes requests of EHR using Access token
- Until user/EHR closes it

# Smart Launch Sequence #1: Stand Alone

- Application wishes to connect to EHR (Mobile/Web/Desktop/Server)
- Creates a browser (thing). Sends browser to auth endpoint
- User discusses the request for access with the Auth server
- Auth server redirects to Application (server) with “auth” token
- Application converts token to Access token
- Application makes requests of EHR using Access token
- Until EHR rejects the access token (go back to start)

# Smart Launch Application Registration

- EHR decides which authorizations to approve
  - Subject to organizational policy and vendor decision making
- Most EHRs require applications to be registered in advance
  - Not necessary technically, but enforce policy and business practices
  - Enforce business agreements
  - Check security & useability
- This becomes the focus point of contention around financialization

# Smart Launch User Authentication

- Smart App Launch doesn’t require the user to be identified
  - But can be, and almost always needs to be
  - Authorization outcome may include user details (app can ask for this)
- Typically EHR must identify a user to decide what records are accessible
- Client may also need to authenticate user for it’s own purposes
  - Unless it can match records from EHR details
  - Can set up SSO arrangements with EHR
- EHR can delegate user authentication (e.g. national service) using 2nd stage OAuth (not Smart though)

# Smart Launch: Scopes and Tokens

- EHR & Apps inject tokens (unique identifiers) into the process
  - Track context for both parties (e.g. Launch Context)
  - There are various encryption and signing steps to secure the exchange

- App requests a set of ‘scopes’. EHR grants a set of scopes
  - Each scope has scope/type.mode e.g. `patient/Observation.rs`
  - EHR can grant more or less access, depending on internal policies, institution policies, user rights etc
  - Scopes are a language for the interaction with the user – what is the app proposing to do?

# Why use SMART on FHIR?

- All the advantages of FHIR, e.g.:
  - Free Open Source Specification
  - Leverage Web technology / security / community
  - Active & helpful FHIR community
- Can use other standards
  - V2 – designed for back-office exchange
  - CDA / XDS – designed for historical record collection
- Can do it your own way (down with standards)

# Standards Cost More!

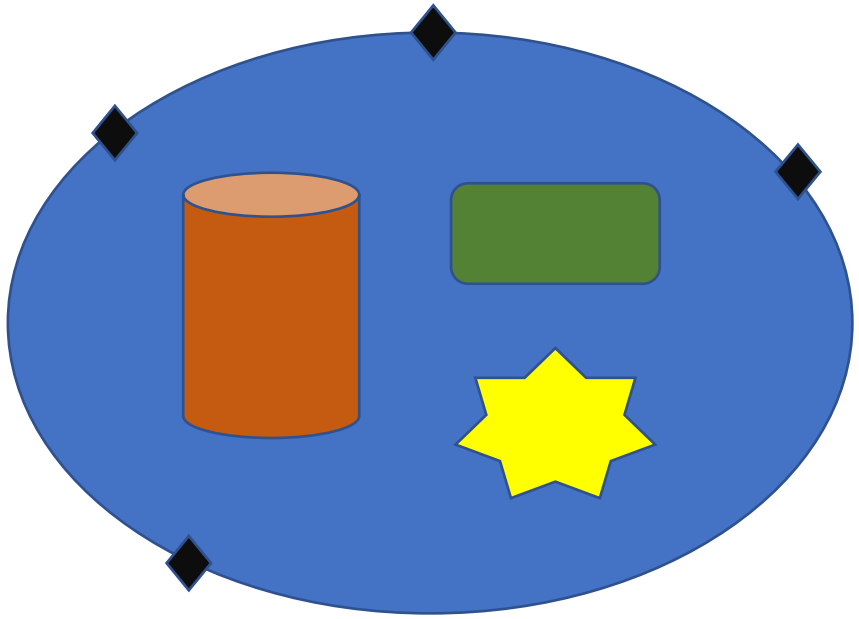
- Standards increase up front costs
  - Encountering requirements you don't (*yet*) have
  - More development than a custom agreement
- Standards decrease follow up costs
  - More re-use of work in the future
  - Less re-work (safer! Lower Risk!)
  - Easier (cheaper) to find staff & maintain institutional memory
  - More likely to be compliant with regulation
- Can't achieve data lock-in by dead-end-thinking

# Software Process

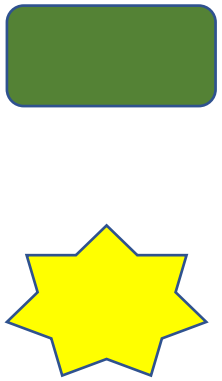
- Most clinical systems are extremely configurable
- In fact: frameworks for systems, not systems
- Extensive implementation project to build a custom configuration
- ‘ERP style software’ e.g. SAP – organization spends significant portion of budget managing it’s own special business rules
- ‘SaaS style software’ – much reduced customization saves an organization real budget
  - Eating the market from small → large
  - Based on ‘Deep Interoperability’

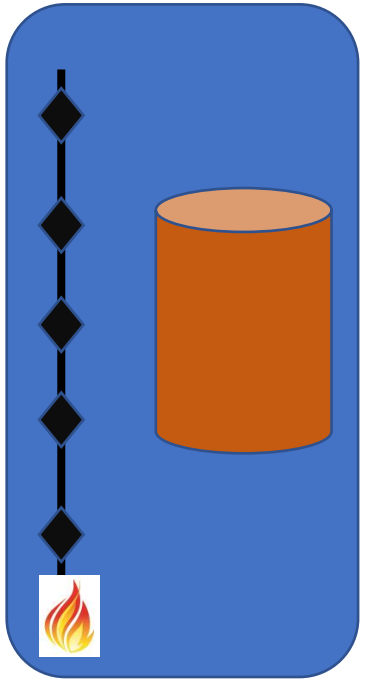
# Shallow vs Deep Interoperability

- Integration points on the perimeter:



- Integration Points part of the system:





# Hacking FHIR: Is it secure?

- Alissa Knight is a professional hacker who was paid to hack production APIs and publish her results
- EHRs were very secure. Other Apps: very insecure
- This is scary! Why use FHIR?
- Because you will be hacked – so why not be part of the solution?

# Lessons Learned - Alissa

- Public notification of a security breach will generate real controversy
- Much of it misinformed & some of it malicious
- There will be real political costs
- Handling it properly pays off – be prepared
- Ecosystems based on open standards are more resilient
  - Economics justifies white hat hacking

# Lessons Learned

- Implementers are all over the place
  - Some implementers are very good indeed
  - Some implementers are not!
  - Culture matters. Leadership matters
- Solutions vary widely between jurisdictions
  - Responding to different risks, driven by different purchasing choices
- Implementers / adopters that are suspicious of new technologies (cloud) are not suspicious enough of their existing practices

# FHIR is not a silver bullet

- FHIR is a nice technology
- The FHIR specification only captures what everyone will agree to
  - “Platform” on which to build agreements
- People still have to agree about everything else
  - Countries
  - Domains
  - Terminologies
  - Business Agreements / workflows
  - Framework & Motivation for introducing it

# Building Community

- Strategy / Architecture
  - Vendors and institutions need leadership to get over co-dependency issues
- Education
  - Formal education (University)
  - Professional education
- Learning / Testing Opportunities
  - “Connectathons” / Sandbox - opportunities for technical teams to test/learn with no risk
- Local Specifications
  - Convert local issues to local specifications – regulation, language, accepted business practices

# International Specifications

- IPS: International Patient Summary
  - A set of agreed summary information about a patient
  - Common Content + Terminology rules
  - Portable as they travel (tourist/refugees/civil disruption)
  - Doesn’t specify how transfer happens – can be by Smart on FHIR
- IPA: International Patient Access
  - A common way to access information for a patient in any country
  - Unbundle US Patient access from US Specific content rules
  - Because consumer technology is international in focus
  - Doesn’t make rules about content, just how to access information
  - Smart on FHIR for patients

# Patient Oriented Systems

- Clinical systems and their safety is often measured ‘compartmently’
- Patient outcomes are hard to measure and hard to improve
- Patients have little influence over the process or the outcomes

- FHIR Project has the ultimate goal of improving patient outcomes

# Empowering Patients

- Make data accessible to Patients
- Make data from patients accessible to system
- Allowing patient to control data sharing between parties
- Creating a single common patient record

- But: Services not Data are empowering
- FHIR offers the ability to extend services to the patient

# Coordinated Care

- Common Frustration of Patients:
  - Scheduling/Communication problems
  - Conflicting care plans / payment options
  - Conflicting system definitions of success
  - Must be resolved by the patient
- FHIR enables Services for
  - distributed care plan
  - virtual clinical review
- Virtual Institutions (internet hospitals, institutional boundaries)
- Integrated Home Care (medication management)

# FHIR & Disruption

FHIR disrupts healthcare (& healthcare IT):

- Significantly reducing the cost of data exchange
- Making it easy and natural to use the web
- Encouraging the development  of open community
- Building a solid base to scale computation about healthcare

At the same time as wider web / open community transforms are happening.

Join a community….