



Advancing from HL7 to FHIR - An Introduction

HL7 Hong Kong

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Who Am I?

- Degree in Biochemistry / Botany from Auckland Uni
- 6 years – Hospital Laboratory / Medical Research
- 14 years – Lead Dev / CTO @ Health Systems ISV
- 13 years - Consulting / Contracting Health Data Exchange

- Now: FHIR Community Lead / Product Director



Why FHIR? – State of Healthcare (2011)

- Health care has broken processes
 - Accountability for the parts, but no matching overall accountability
- Healthcare doesn't have good support from IT
 - IT enables process transformation in other industries
- Change is hard in healthcare
 - IT is not enabled (2011)
 - There are many other challenges



Why FHIR? – State of HL7 (2011)

- HL7 v2 – widely adopted in many countries
 - Old technology | messy definitions
 - Custom parser – many problems in practice
 - Doesn't fit into modern development stack -> Web architecture
- CDA – Clinical Document
 - Documents have a clear but limited scope
 - Content not compatible with v2
 - Clinical concepts represented with difficulty
- V3 – an ambitious idea that had run its course



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
- A web API - web standards where possible
- Continuity with existing healthcare standards
- Public Treasure (<http://hl7.org/fhir>)



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



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,



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



Building the FHIR culture

- Open community – anyone can join
- Produces open standards – community treasure
- Foundation: solid governance backed by ANSI

- Build by iteration and continuous demonstration that trust is rewarded
- Connectathons, Face to face meetings, teleconferences, email lists, community forums, instant messaging, stack overflow



Implementer Focus

- Specification is written for one target audience: implementers
 - not just developers
 - Rationale, modeling approaches, etc. kept elsewhere
- Multiple reference implementations (C#, Java, Pascal, Swift, Javascript...)
- Publicly available test servers
- Connectathons to verify specification approaches
- Lots of example instances you can read and understand
- Provide solid validation framework



Learning FHIR from v2 #1

- FHIR was built from ground up independent from v2
- But many of the basic concepts are evolutions of what is in V2



Strengths of v2

- Widely understood / High market penetration
- Flexible adaption to local requirements
- Cheap to roll out once implemented
- Not too hard to implement (standard is not too deep)
- Underlying notions of v2 definitions have very high penetration



Underlying Suppositions

- HL7 cannot dictate technical or enterprise architecture, or how an application actually works
- "Drive-by Interoperability"
 - Vendor arrives at an institution
 - Has to exchange messages with deadly enemy with short lead time and no follow up
 - Institution has special local business rules
- *Worst case Interoperability*



Weaknesses of V2

- Only good for integration at the perimeter (Shallow, short-sighted)
- Inconsistent, incoherent, incomplete definitions
- No good way to build complex structures
- Different cultures and integration communities
- While you can vary for local institution, you generally have to, even when it's not useful
- Cannot scale for Enterprises or Government
- Cannot build coherent architecture this way
- Fixed to a frozen technical base (vertical bar/ LLP)



FHIR compared to v2

- **Segment = Enhanced Resource**
- Messaging paradigm broken up into modules
- Use web technology for formats, exchanges
 - Vertical Bar → JSON/XML, MLLP → HTTP
- Much work on query
- Significant work on terminology support
- Deep investment in profiling / implementation guides / validation
- Add narrative (like CDA) and z-slots everywhere
- Addition of questionnaire support

MSH|^~\&|LCS|LCA|LIS|TEST9999|199807311532||ORU^R01|3629|PI|2.2
PID|2|2161348462|20809880170|1614614|20809880170^TESTPAT||19760924
ORCINWI8642753100012^LISI20809880170^LCSI|||||19980727000000||||HAVA
OBRI1|8642753100012^LISI20809880170^LCSI008342^UPPER RESPIRATO
OBX|1|STI008342^UPPER RESPIRATORY CULTURE^LI|FINALREPORT|
ORCINWI8642753100012^LISI20809880170^LCSI|||||19980727000000||||HAVA
OBRI2|8642753100012^LISI20809880170^LCSI997602^L|||1998072717580
OBX|2|CEI997231^RESULT 1^LI|M415|||||NIF|||19980729160500|BN
NTEI1|LI|MORAXELLA (BRANHAMELLA) CATARRHALIS
NTEI2|LI|HEAVY GROWTH
NTEI3|LI|BETA LACTAMASE POSITIVE
OBX|3|CEI997232^RESULT 2^LI|MR105|||||NIF|||19980729160500|BN
NTEI1|LI|ROUTINE RESPIRATORY FLORA



Common Problems with ORU processing

- Who's the patient?
- Is this a new report or an update?
- Do we have new OBXs?
- How do you decide what data has changed?
- How do you remove data (fields – "". Segments?)
- What do you have to send? (When do you send it?)



Segment PID

- PID|2|2161348462|20809880170|1614614|20809880170^TESTPAT||19760924|M|||^^^00000-0000|||||86427531^^^03|ISSN# HERE
- PID:[342424324](#)|2|2161348462...
- PID:[laboratory/342424324](#)|2|2161348462...
- PID:[http://lab.acme.org/v2/pid/342424324](#)|2|2161348462...



Accessing the segment:

<http://lab.acme.org/v2/pid/342424324>

- Read (GET) the segment
- Create it (POST)
- Update it (PUT)
- Delete it (DELETE)

- Find it – search by parameters:
<http://lab.acme.org/v2/pid?f3=20809880170>

ORU Structure



| Segment | Cardinality | Implement | Status |
|-----------------------|-------------|-----------|--------|
| ORU^R01^ORU_R01 | | | |
| MSH | [1..1] | SHALL | |
| SFT | | | |
| UAC | [0..1] | | |
| PATIENT_RESULT | [1..*] | SHALL | |
| PATIENT | [0..1] | | |
| PID | [1..1] | SHALL | |
| PD1 | [0..1] | | |
| PRT | | | |
| NTE | | | |
| NK1 | | | |
| ARV | | | |
| + PATIENT_OBSERVATION | | | |
| + VISIT | [0..1] | | |
| ORDER_OBSERVATION | [1..*] | SHALL | |
| + COMMON_ORDER | [0..1] | | |
| OBR | [1..1] | SHALL | |
| NTE | | | |
| PRT | | | |
| + TIMING_QTY | | | |
| CTD | [0..1] | | |
| OBSERVATION | | | |
| OBX | [1..1] | SHALL | |
| PRT | | | |
| NTE | | | |
| FT1 | | | |
| CTI | | | |



Unpeel the ORU

- OBX:{url}|1|STI008342^UPPER RESPIRATORY CULTURE^LI|FINALREPORT|||||NIF|| 19980729160500|BN ORCINWI8642753100012^LI
|Patient=<http://lab.acme.org/v2/pid/342424324>
- The OBX now can be accessed from anywhere, not just in the transaction that links to the patient
- Do this everywhere – make the references explicit
 - Provide a way to navigate in either direction



Reformat the OBX

```
<observation>  
  <id = “{url}” >  
    <code>  
      <CWE.1>008342</CWE.1>  
      <CWE.2>UPPER RESPIRATORY CULTURE</CWE.2>  
    </code>  
    <value type= “ST” >FINALREPORT</value>  
    ...  
</observation>
```



FHIR Observation

```
<Observation xmlns="http://hl7.org/fhir">
  <id value="f001"/>
  <code>
    <coding>
      <system value="http://loinc.org"/><code value="15074-8"/>
      <display value="Glucose [Moles/volume] in Blood"/>
    </coding>
  </code>
  <subject><reference value="Patient/f001"/>
    <display value="P. van de Heuvel"/></subject>
  <valueQuantity>
    <value value="6.3"/><unit value="mmol/l"/>
  </valueQuantity>
```



FHIR compared to v2

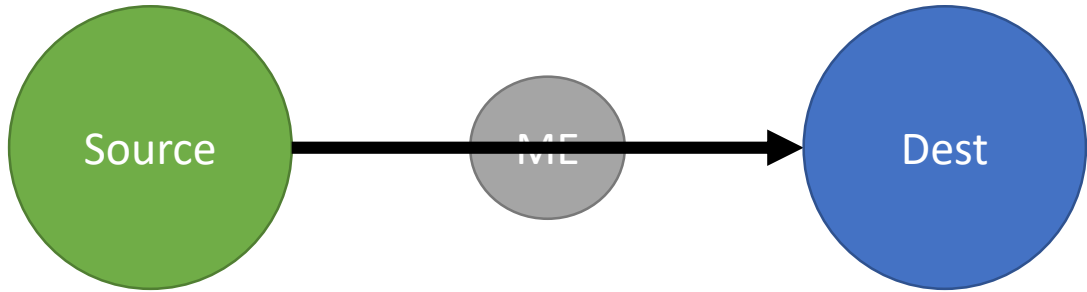
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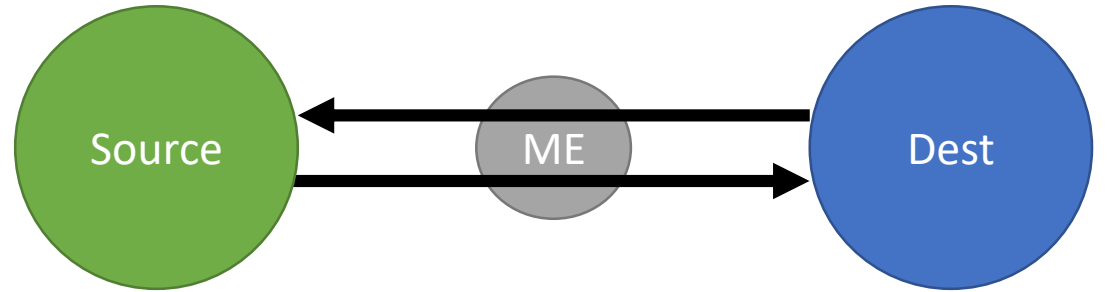
FHIR Exchange Paradigms

- “RESTful”: CRUD Access to resources at their URL
 - CRUD = Create, Read, Update, Delete
 - Basic workhorse of interoperability – client leads, server defends
- Operations: ask server to execute an characterised action
- Transaction: general purpose transaction specification
- Subscriptions: ask for a system to send you what you want
- Messaging – Send message (MessageHeader = MSH)
 - Reproduces v2 messaging, but adds more transport options (HTTP+)
- Document – publish attested documents (like CDA)

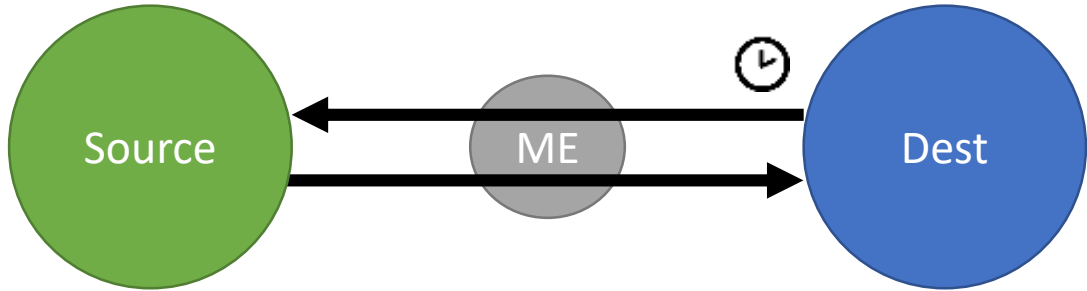
Push



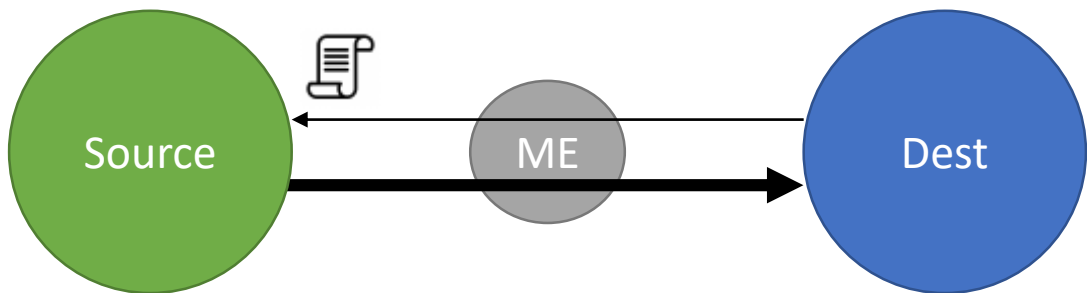
Query



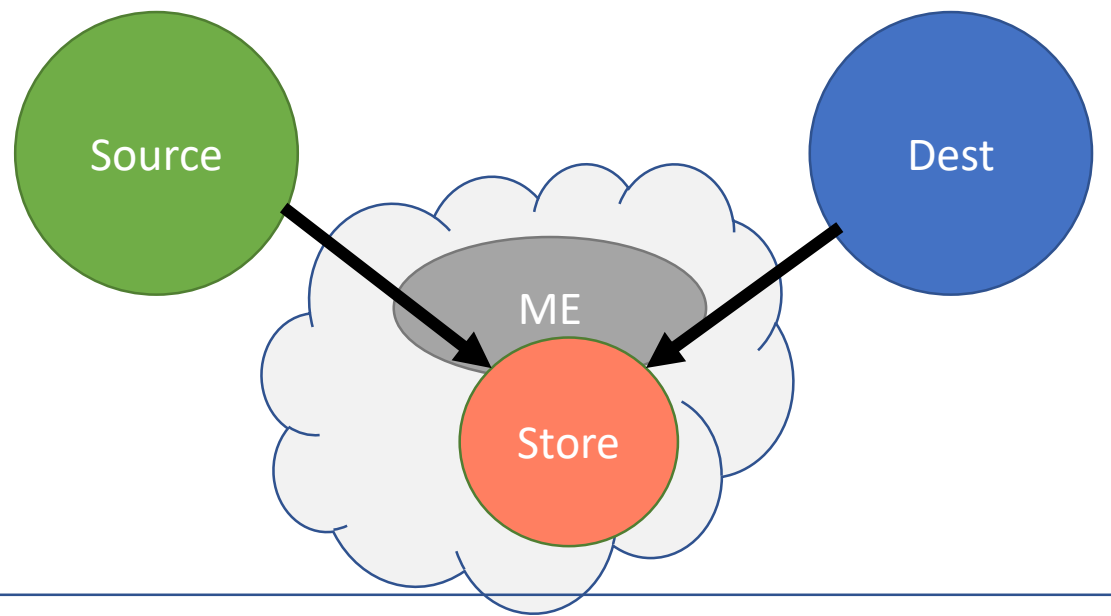
Poll



Poll



Repository



Architecture



- Standalone FHIR Server
- A FHIR Server in front of an existing application (e.g. SQL)
 - FHIR as front end to an XDS server (“MHD”)
- An interface engine that ‘speaks’ FHIR
- A tablet/mobile phone application
- Web portal uses FHIR to access other systems
- A healthcare application that access information from multiple systems as well as it’s own server
- Smart-On-FHIR – an EHR plug-in framework

Application extensibility framework

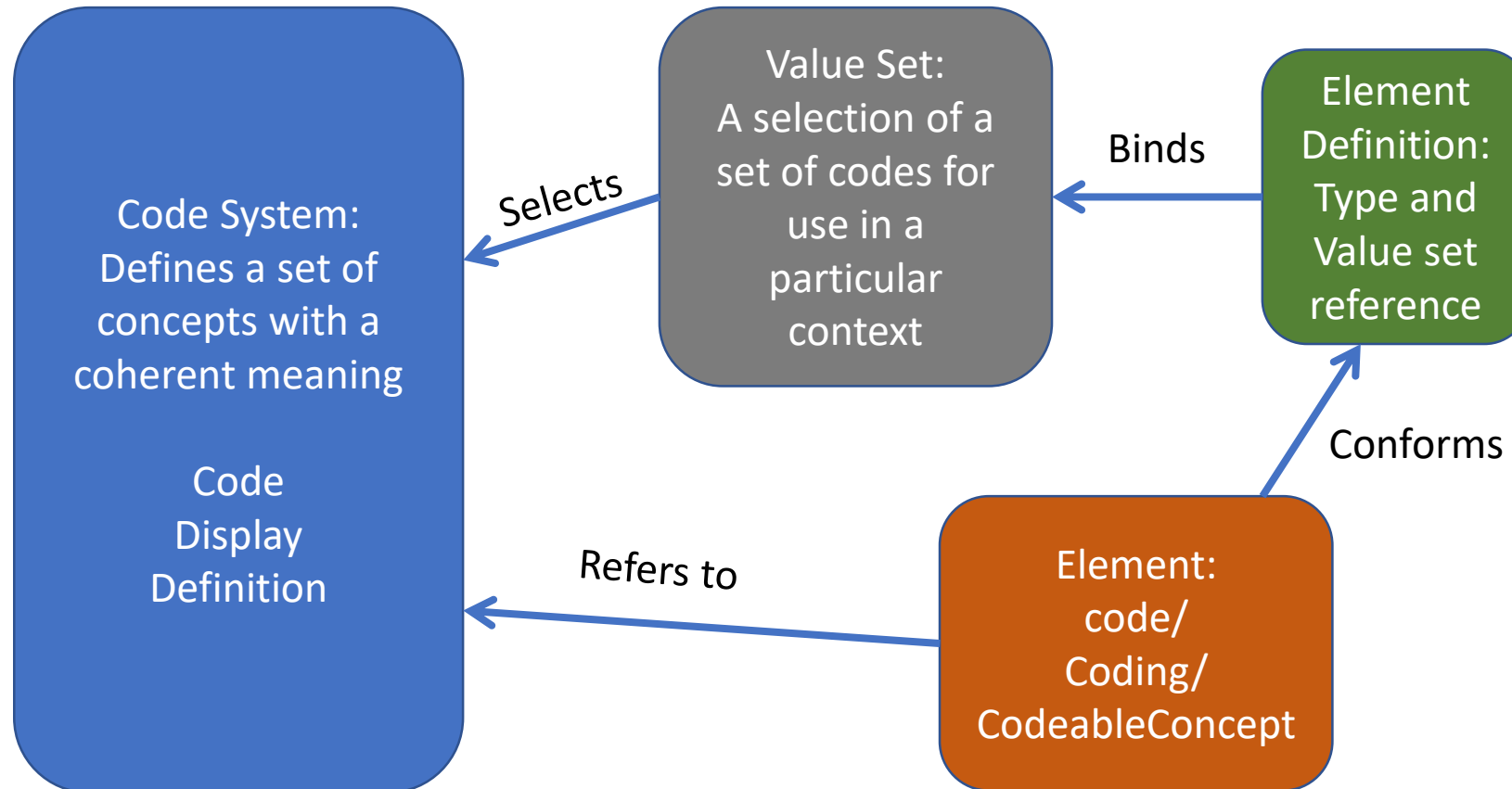
- SMART App Launch deals with many deployment questions
- Integrate FHIR Interfaces into Common Application problems
 - EHR plug-ins for extensibility
 - Integration of User authentication/authorization
 - Clinical Decision Support Infrastructure (cds-hooks)
- Most/Many implementations will use the Smart App Launch
- CDS Hooks – builds on both FHIR + SMART to allow integration of decision support into the UI



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FHIR Terminology





FHIR Terminology

- FHIR elevates terminology to an equal partner in structure
- Re-uses the same framework (resources/exchange) as everything else
- Also provides a run-time service:
 - Get list of codes
 - Validate codes
 - Look up details for a code
 - Translate from one code system to another
- Gives implementations much better tools and control over terminology (but big learning curve for specifiers)



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Limitations of FHIR

- It's a standard – built by a committee of committees
 - Too many cooks spoil the broth
 - Everybody has something they disagree with
- Freedom of the community is constrained by the many participants
 - Can only agree to what everyone agrees to (limited in health)
 - It's the depth of participation that powers it, but it has a cost
- FHIR doesn't aspire to be a comprehensive system design
- Almost all adopters will need additional agreements to get something working



Localization

- FHIR is an international standard
 - All jurisdictions, all kind of functionality
- Countries, Vendors, Projects have to use FHIR
 - Create their own rules – profiles, value sets, mappings, extensions
- FHIR tames Localization
 - Built in extensibility/localization framework
 - Define, publish, find localizations, Use them
 - Tooling for managing this
- This tames the overall specification

Extensions



- W3C rules: must interoperate without extensions – but this is not possible in healthcare
- A Choice
 - design for absolutely everything
 - or allow extensions
- FHIR has a standard extension framework - every FHIR element can be extended
- Every extension has:
 - Reference to a computable definition
 - Value – from a set of known types
- Every system can read, write, store, validate and exchange all legal extensions

Governing Extensions



- Extensions are not a silver bullet
- FHIR has a sliding scale governance for extensions
 - Local Projects
 - Domain standards (e.g. Best Practice Cardiology)
 - National Standards (e.g. Standard Finnish Extensions)
 - HL7 published extensions (corner cases with international scope)

Do you need Implementation Guides?



- Use Case 1: Access to Data (e.g. Personal Health Repository)
 - I want to get data from multiple systems, and display it to a user
 - Not much content agreement necessary (FHIR out of the box)
- Use Case 2: Business Workflow Implementation
 - I want to do ordering/reporting between clinical and diagnostic systems
 - Workflow / business practice agreements needed (IG)
- Use Case 3: Shared Clinical Solutions
 - I want to run the same code as a plug-in to multiple systems
 - Extensive clinical agreements needed (IG on steroids)

Implementation Guide



- A package that describes how an application does or should work, with both:
 - Human readable documentation
 - Computer Processible Specifications
- Specifies:
 - API or other exchange method features & Security
 - Rules for Resource Contents & Extension Usage
 - Details about Terminology usage
 - Mappings to other specifications / terminologies
 - Business Processes

Rules for Resource contents



- Restrict cardinality, including to 0..0
- Fix the value of something, or constrain to a pattern
- Make invariants (rules that must be true)
- Restrict the types (if multiple are allowed)
- Require a type or reference to conform to a profile
- Bind to a different terminology
- Provide additional definitions, usage notes etc
- Provide more specific or additional mappings
- Make rules about must-support



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Connectathons



- Open invitation to any interested party to come and write software that exchanges FHIR resources
- Always hold one before HL7 meetings (last week) + Others by invitation (none in Asia – yet!)
- 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... (<http://chat.fhir.org> – join!)



FHIR Maturity Model

- 0 Published on Current Build
- 1 + No warnings (internal QA), ready for implementation testing
- 2 + has been tested at a connectathon
- 3 + balloted with >10 comments from >3 orgs, at least one change
- 4 + tested across scope, published in a DSTU, multiple implementations
- 5 + 2 DSTU cycles, ≥ 5 production systems, multiple countries
- 6 Normative: formal standard, no breaking changes



Goals of the FHIR Project

- Disrupt Healthcare IT Standards
 - More open, More responsive, Modern approach
 - Largely Completed
- Disrupt Healthcare IT
 - Interoperability as a way of life
 - Reduce the cost of interoperability (90%!)
 - In progress
- Disrupt Healthcare



To Centralise vs To Distribute?

- Centralising Data
 - Natural choice of any information manager (single point of service / risk)
 - Allows for creative joins (once quality issues resolved)
 - Since combined security/consent framework – all or nothing
 - Data is a toxic asset
- Distributing data
 - Requires more technical confidence
 - Can still join, but not at scale (good | bad?)
 - Distributes your risk & your problems (mgmt. issue)
- Well designed APIs allow flexibility (resilience!)



The Web is disruptive

- The web has created new ways for information to flow
- Good at scalability, bad at observing (any) boundaries
- Unhooking information availability from transaction gates has destroyed businesses and created new ones
 - Old style taxis → Uber
 - Bricks & Mortar shops → Amazon
 - Media (newspapers) → Social Media giants
- Disruption has been both good and bad across the board



Patient Care Settings

- Fragment Healthcare system = gaps / discontinuities in the system
- People fall into those gaps, become needless casualties
 - Not the only safety problem but a significant factor in many/most
- Clinical process governance = clinical record boundary
- Information Management builds & Reinforces the boundaries
 - It's not an **IT** problem
- Institutional boundaries not good for patients or carers
 - Value the primary carer



Patients and APIs

- Use APIs to give patient's access to their own data
- From Patient's POV:
 - Small % of patient's lives change because they have data
 - Need services. Data is a precondition for services
 - Distributed healthcare services are the future
- From Institutions POV:
 - Can work around huge technical debt in sharing policy
 - Reduces cost burden to do integrations
 - But a huge cultural leap



Join the Community

- FHIR is a critical infrastructure enabler
 - A community solution for the IT requirements
- But FHIR is not a solution to anything itself
- Need new community infrastructure at many levels
 - Governance is critical: Build confidence and trust – open community treasure
 - Needs stable Governance foundations with consistent transparency
- Join the community (FHIR, or others)
 - <http://hl7.org/fhir>, <http://fhir.org>