C-CDA on FHIR

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HL7 Webinar

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Instructor

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    - Improve healthcare through health information technology (IT)
    - Lead the industry through our consulting and volunteer practice
  - Our Services:
    - Software & standard development & implementation
    - Terminology, data governance, and education
    - Strategic advice for health IT planning, design, and purchasing

Outline

- Overview of Clinical Documents

- CDA and C-CDA

- FHIR documents

- C-CDA on FHIR and US Core

- Converting data to/from C-CDA and FHIR

- Current/Future Work and Resources

- Live walkthroughs (time permitting)

Clinical Documents

- This is a document
- and this
- and this
- and this
- and this

Clinical Documents

- **Persistence** – A clinical document continues to exist in an unaltered state, for a time period defined by local and regulatory requirements. <u>Note</u>: documents outlive the servers (and often the syntax) on which they are created.

- **Stewardship** – A clinical document is maintained by an organization entrusted with its care.

- **Potential for authentication** – A clinical document is an assemblage of information that is intended to be legally authenticated.

- **Context** – A clinical document establishes the default context for its contents.

- **Wholeness** – Authentication of a clinical document applies to the whole and does not apply to portions of the document without the full context of the document.

- **Human readability** – A clinical document is human readable.

Why are documents important?

- The dual nature of the clinical record:
  - Data
  - Narrative

- Documents support that duality
  - Essential for disparate teams—different disciplines, contexts, or clinical systems
  - Developers need coded data to drive applications
  - Clinicians often say that the most important part of the clinical record is the narrative written by their colleagues

Clinical Document Architecture (CDA)

- A specification for exchange of clinical documents, defining their structure and semantics

- ANSI/ISO standard developed by HL7's Structured Documents Work Group (SDWG)

- Base standard on which many Implementation Guides (IGs) are built:
  - Quality Reporting Document Architecture (QRDA)
  - Healthcare Associated Infection (HAI) Reports
  - Consolidated CDA (C-CDA)
  - …and many others

Consolidated CDA

- HL7 Consult Note
- HL7 Diagnostic Imaging Report
- HL7 Discharge Summary
- HL7 History and Physical
- HL7 Operative Note
- HL7 Procedure Note
- HL7 Unstructured Documents
- HL7 Progress Notes
- HL7 Continuity of Care Document
- HITSP/C84 Consult and History & Physical Note Document
- HITSP/C32 - Summary Documents Using HL7 CCD
- HITSP/C48 Referral and Discharge Summary Document constructs
- HITSP/C62 Scanned document

Consolidate and harmonize various standalone documents into one master implementation guide for the primary care use case.

Later versions added additional document types.

Why C-CDA on FHIR?

- Since C-CDA exists, do we need a FHIR version?
  - A little history and context is needed to answer that question…

In the Beginning…

- Good old HL7 V2
  - Proprietary, idiosyncratic syntax
  - Fixed field
  - Z-segments for extensibility
- Did well enough
  - Interfaced early administrative, clinical systems with administrative data (ADT)
  - Labs – sort of, still struggling with standard coding
  - Some registries (e.g., immunization)
- Did poorly or not at all
  - Clinical decision support
  - Claims adjudication (attachments)
  - Extra-enterprise continuity of care
  - Value-based care

HL7 Version 3

- Model-based
- XML default syntax
- Introduced "sparsely populated tree structure" for clinical documents (Clinical Document Architecture, CDA)
  - Rich clinical content
  - Narrative & structured data
- In theory, one model/syntax/methodology for both messages & documents
- In practice, overly complex and still idiosyncratic

Clinical Document Architecture (CDA)

- **Clinical documents**
  - Defined: authenticated part of clinical record, less like EDI and more like a contract
  - Human readability: required
  - Machine readable (coded data): option, defined by templates, per use case
- **"Architecture": constrain for specific use cases**
  - Continuity of Care
  - Discharge Summary, H&P, etc.
  - Healthcare Associated Infections
  - Quality Reporting…

CDA (Continued)

- **But needed to conform to V3 methodology**
  - Ideal: data moved in/out of documents seamlessly through V3 API
  - Reality: V3 messaging impractical
- **Some things work well, some not so well**
  - Good: human readability, single stylesheet rendering, consistent metadata
  - Not so well: template definition complex, narrative/coded data management
  - No comparable messaging/API

What can be improved?

- Grahame's Law:
  - You can hide complexity, or **make it worse**, but you can't make it go away.
- HL7 V3 was more complex than necessary.
  - Simple technical problems became road-blocks for many implementers.
- CDA was the stable, simpler part of HL7 V3.
  - But inherited much of the V3 complexity
  - Never had a viable API complement
- FHIR makes many simple problems simple again.
  - Lets implementers focus on solving the hard problems.
- Many CDAs today are just EHR data dumps.
  - FHIR Queries can serve the same purpose with more specificity.
  - The future: less data dump documents, more clinically relevant documents

The Acronym

- **F – Fast (to design & to implement)**
  - ➢ Relative – No technology can make integration as fast as we'd like
- **H – Health**
  - ➢ That's why we're here
- **I – Interoperable**
  - ➢ Ditto
- **R – Resources**
  - ➢ Building blocks – more on these to follow

FHIR in a Nutshell

- FHIR is like Lego(™) for Healthcare
- Resources = Blocks
- Resources are discrete chunks of clinical information
- Resources can be assembled into larger constructs
- You operate on resources via FHIR's REST APIs - like programming Lego Mindstorms (™)

FHIR Manifesto

- Focus on **implementers**
- Keep **common scenarios** simple
- Leverage **existing technologies**
- Provide **human readability**
- Make content **freely available**
- Support multiple **paradigms & architectures**
- Demonstrate best practice **governance**

FHIR and CDA

Similarities

- Support profiling for specific use-cases
- Human readability is minimum for interoperability
- Validation tooling, profile tooling

FHIR Differences

- Can use out of the box – no templates required (but profiling still recommended)
- Not restricted to just documents
- Implementer tooling generated with spec
- Tighter coupling to APIs (RESTful services)

FHIR Documents

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Intersections

POSITION STATEMENT: CLINICAL DOCUMENTS AND FHIR

Adopted August 1, 2014; revised April 10, 2015

This position statement addresses the relationship between HL7's Clinical Document Architecture (CDA) product line and the Fast Health Interoperability Resource (FHIR) product line. It was prepared jointly by Lantana Consulting Group—a recognized leader in the CDA community—and Grahame Grieve, Health Intersections, the FHIR project lead. This statement is not official policy. It is our hope that it will stimulate discussion and possibly guide policy makers, architects, and implementers as well as standards developers.

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FHIR Documents

- Position: FHIR is the document future

- Call to action:
  - Define, document, and promote a future where clinical documents and Application Programming Interfaces (APIs) share a common syntax and set of resources
  - Establish, in technical and regulatory policy, a smooth roadmap to the future of clinical document exchange

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FHIR Documents

- Addresses CDA use case for clinical documents
- Collection of resources bound together
  - Root is a Composition resource
  - Much like the CDA header + narrative
- Sent as a Bundle resource
- Can be signed, authenticated, etc.
- A FHIR document has the same basic obligations as a CDA document
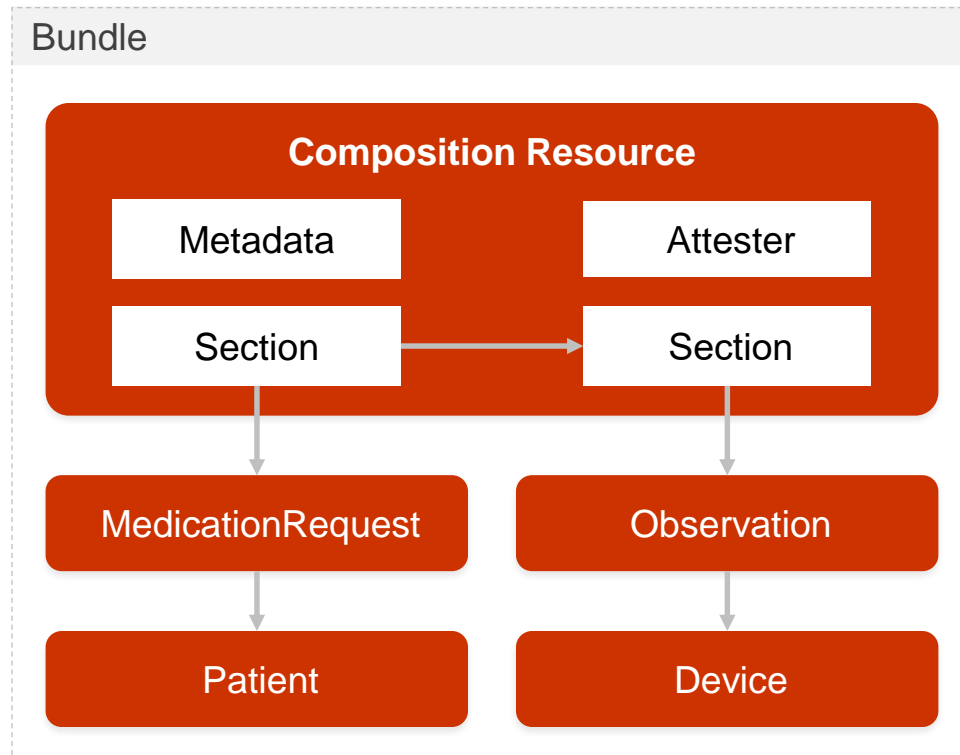- Full rules
  - http://build.fhir.org/documents.html

Why FHIR Developers Might be Interested in Documents

- Load FHIR servers with massive amounts of existing data
  - Most EHRs export CDA
  - Their CDA export capabilities are more stable than many of their FHIR APIs (if any)
  - Converting CDA to FHIR is one of the the quickest standardized path to Big Data in healthcare today
- Comply with existing requirements
  - FHIR is simpler than CDA
  - Teach developers to create FHIR documents, then convert to CDA for compliance with existing regulations
    - FHIR as an API for creating CDA documents
- Prepare for when FHIR documents are the norm
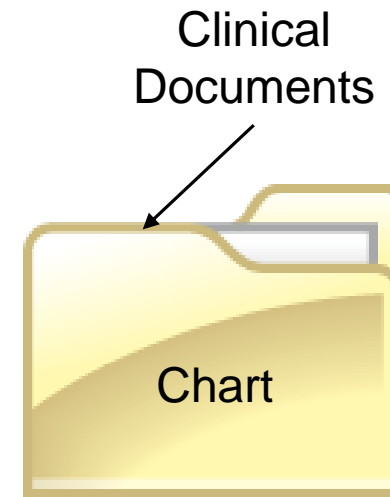
Composition Resource

- Contains
  - Patient
  - Author
  - Custodian
  - Type of document
    (e.g., Discharge summary)
  - Attested narrative of the document

- Sufficient for
  - Medical records management
  - Document management
  - Enable clinical document exchange across and within institutions
  - Human readable documents

Clinical
Documents

Chart

Composition in Detail

- **Key fields**
  - ➢ Identifier
  - ➢ Date
  - ➢ Type
  - ➢ Subject
  - ➢ Author
  - ➢ Attester
  - ➢ Custodian
  - ➢ Sections and narrative
  - ➢ References to other resources

Name	Flags	Card.	Type	Description & Constraints
Composition	TU		DomainResource	A set of resources composed into a single coherent clinical statement with clinical attestation Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..1	Identifier	Logical identifier of composition (version-independent)
status	?! Σ	1..1	code	preliminary | final | amended | entered-in-error CompositionStatus (Required)
type	Σ	1..1	CodeableConcept	Kind of composition (LOINC if possible) FHIR Document Type Codes (Preferred)
class	Σ	0..1	CodeableConcept	Categorization of Composition FHIR Document Class Codes (Example)
subject	Σ	0..1	Reference(Any)	Who and/or what the composition is about
encounter	Σ	0..1	Reference(Encounter)	Context of the Composition
date	Σ	1..1	dateTime	Composition editing time
author	Σ	1..*	Reference(Practitioner | PractitionerRole | Device | Patient | RelatedPerson | Organization)	Who and/or what authored the composition

Sections and Narrative

- Composition resources contain sections (which may be nested)

- The section narrative markup is XHTML

- The narrative contains the attested text of the document

- It is ok for sections to consist of only human readable text (i.e., no machine processable resources)

First: Human Readable

```
<section>
  <title value="Allergies and Intolerances"/>
  <code>
   <coding>
    <system value="http://loinc.org"/>
    <code value="48765-2"/>
    <display value="Allergies and adverse reactions"/>
   </coding>
  </code>
  <text>
   <status value="generated"/>
   <div xmlns="http://www.w3.org/1999/xhtml">
       <ul>
        <li>Penicillin - Hives</li>
        ...
       </ul>
   </div>
  </text>
  ...
</section>
```

Allergies and Intolerances

- Penicillin - Hives

Next: Coded Data

```xml
<AllergyIntolerance xmlns="http://hl7.org/fhir">
<clinicalStatus value="active"/>
<verificationStatus value="confirmed"/>
<category value="medication"/>
<criticality value="high"/>
<code>
 <coding>
  <system value="http://snomed.info/sct"/>
  <code value="418038007"/>
  <display value="allergy to penicillin"/>
 </coding>
</code>
<patient>
 <reference value="Patient/1"/>
 <display value="Henry Levin"/>
</patient>
<assertedDate value="2000"/>
 <reaction>
  <manifestation>
   <coding>
    <system value="http://snomed.info/sct"/>
    <code value="247472004"/>
    <display value="hives"/>
   </coding>
  </manifestation>
  <severity value="mild"/>
 </reaction>
</AllergyIntolerance>
```

A Bit of Bundle

- Type = document
- Bundle.identifier
  - Version dependent
  - Must be globally unique to satisfy the persistence requirement
- First entry is a Composition
- Documents must be standalone, so…
- The bundle contains all resources referenced from the Composition

Name	Flags	Card.	Type	Description & Constraints
Bundle	Σ I N		Resource	Contains a collection of resources + FullUrl must be unique in a bundle, or else entries with the same fullUrl must have different meta.versionId + A document must have an identifier with a system and a value + entry.request only for some types of bundles + entry.response only for some types of bundles + total only when a search or history + entry.search only when a search Elements defined in Ancestors: id, meta, implicitRules, language
identifier	Σ	0..1	Identifier	Persistent identifier for the bundle
type	Σ	1..1	code	document | message | transaction | transaction-response | batch | batch-response | history | searchset | collection BundleType (Required)
timestamp	Σ	0..1	instant	When the bundle was assembled
total	Σ I	0..1	unsignedInt	If search, the total number of matches
link	Σ	0..*	BackboneElement	Links related to this Bundle
relation	Σ	1..1	string	See http://www.iana.org/assignments/link-relations/link-relations.xhtml#link-relations-1
url	Σ	1..1	uri	Reference details for the link
entry	Σ I	0..*	BackboneElement	Entry in the bundle - will have a resource,

References in Bundles

```xml
<?xml version="1.0" encoding="UTF-8"?>
<Bundle xmlns="http://hl7.org/fhir">
  <id value="ee5590ab-72c0-4c07-9dc0-cc574729cd0a"/>
  <type value="document"/>
  <entry>
    <fullUrl value="urn:uuid:511b05b3-8c3d-4cbe-b9d8-fe5f8666f994"/>
    <resource>
      <Composition>
        <subject>
          <reference value="urn:uuid:9f334dba-57b1-47bf-a2ba-a60d9583c8bb"/>
        </subject>
        ...
      </Composition>
    </resource>
  </entry>
  <entry>
    <fullUrl value="urn:uuid:9f334dba-57b1-47bf-a2ba-a60d9583c8bb"/>
    <resource>
      <Patient>...</Patient>
    </resource>
  </entry>
</Bundle>
```

This example shows UUID URIs, but can be a FHIR server URL such as http://example.org/fhir/Patient/1

Rendering FHIR Documents

- When the document is presented for human consumption, applications SHOULD present the collated narrative portions in order:
  - Composition.subject -> Patient.text
  - Composition.text
  - Composition.section.text
- Reference stylesheet (XSLT)
  - Document2HTML.xslt in the XML Tools download
  - http://hl7.org/fhir/downloads.html

FHIR APIs

- **REST = "Representational state transfer" – an architecture for how to connect systems**
  - Based on HTTP, the protocol that powers the Web
  - Outcomes
    - Simple stable interfaces
    - High Performance / Scalability
    - Visible Process (e.g., can debug)
    - Portability
    - Reliability (resistance to failure)
- **REST in FHIR**
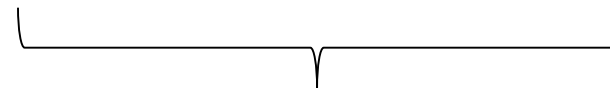 - The FHIR API is composed of RESTful web services

FHIR RESTful URLs

- CRUD(E) operations mapped to HTTP
  - Create new resource: POST to the resource type endpoint
  - Read existing resource: GET
  - Update existing resource: PUT
  - Delete existing resource: DELETE
  - Execute: Use $operations in the URL

resource type

`https://server.org/fhir/Patient/1`

endpoint

id

Documents and FHIR APIs

- **Generating documents**
  - $document
  - Stores at the /Bundle endpoint if persist=true
- **Moving documents or storing externally created documents**
  - Send to /Bundle or /Binary depending on your use case
  - Use PUT to preserve IDs when sending to /Bundle (first, make sure globally unique)
- **Decomposing documents**
  - POST to the transaction endpoint (May need to be converted to a transaction bundle first)

Brief History of CDA to FHIR Mapping

- Initial CDA to FHIR mappings
  - Purpose: Answer the question, "Can FHIR handle the CDA use case?", and fix FHIR if the answer is no.
  - Based on FHIR DSTU1, so mostly for historical reference
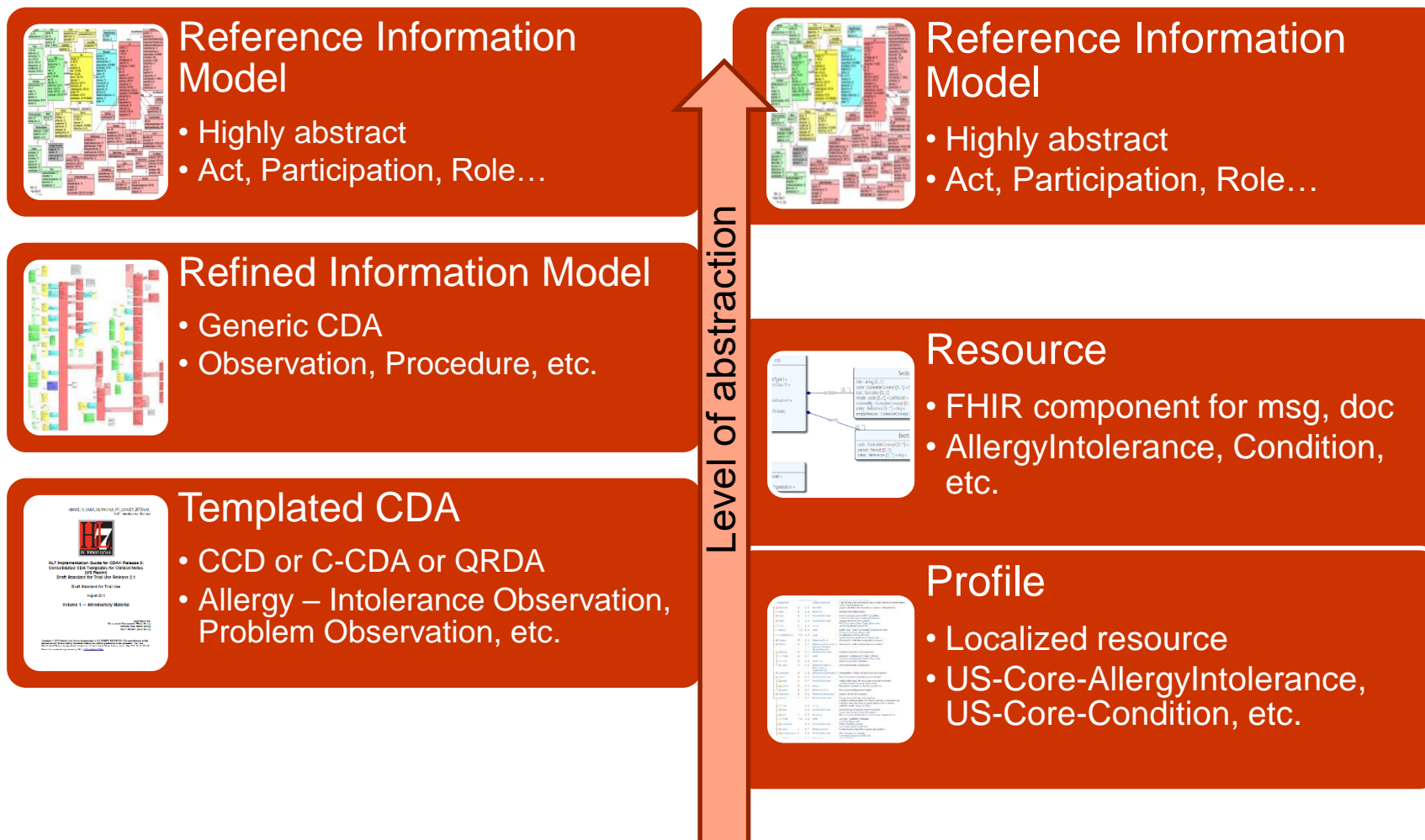 - http://tinyurl.com/jqyc4l8

- Argonaut Project C-CDA to FHIR mappings
  - Conceptual mappings of C-CDA to FHIR, for use by analysts
  - Based on pre-DSTU2 FHIR (resulted in key changes to DSTU2)
  - http://tinyurl.com/zhj2u9s

- C-CDA on FHIR project
  - Implementable profiles targeting FHIR STU3
  - http://wiki.hl7.org/index.php?title=C-CDA_on_FHIR

CDA Templates vs. FHIR Resources and Profiles

Reference Information Model
- Highly abstract
- Act, Participation, Role…

Refined Information Model
- Generic CDA
- Observation, Procedure, etc.

Templated CDA
- CCD or C-CDA or QRDA
- Allergy – Intolerance Observation, Problem Observation, etc.

Level of abstraction

Reference Information Model
- Highly abstract
- Act, Participation, Role…

Resource
- FHIR component for msg, doc
- AllergyIntolerance, Condition, etc.

Profile
- Localized resource
- US-Core-AllergyIntolerance, US-Core-Condition, etc.

FHIR Implementation Guides and Profiles

- FHIR IGs are collections of profiles, value sets, examples, resource instances (conformance, etc.) and human readable documentation.

- There is an ImplementationGuide resource that ties it all together

- Publishing FHIR IGs is a rather new and tricky process

C-CDA on FHIR

- **US Realm FHIR implementation guide**
- **Picked up where the Argonaut mappings left off**
- **Goal:**
  - Implementable FHIR profiles for the C-CDA use case

C-CDA on FHIR Scope

- To represent Consolidated CDA Templates for Clinical Notes (C-CDA) 2.1 templates using FHIR profiles

- This first stage of the project defines all the C-CDA document-level profiles on the Composition resource and contained sections.

- Any coded data used by sections will be accomplished by referencing relevant US-Core FHIR profiles.

Finding C-CDA on FHIR

- **Published specification**
  - http://hl7.org/fhir/us/ccda/index.html
- **Current build**
  - http://build.fhir.org/ig/HL7/ccda-on-fhir/

C-CDA on FHIR Details

- Included in the specification
  - Composition profiles
  - Composition resource examples
  - Extensions
- Not included (yet)
  - Mappings
  - Profiles on resources other than Composition
  - Unstructured Documents
    - May be a profile on DocumentReference

US Realm Header

- Generic constraints that apply to all US Realm documents
- References common US Realm extensions
- Abstract
  - Not mean to be implemented standalone
  - Base profile for all C-CDA on FHIR Composition profile

Name	Flags	Card.	Type	Description & Constraints
📁 Composition		0..*		
📁 language		1..1	code	language
📁 identifier		1..1	Identifier	identifier
↗ subject		0..1	Reference(US Core Patient Profile), Reference(Group)	
📁 date		1..1	dateTime	date
↗ author		1..*	Reference(US Core Practitioner Profile), Reference(PractitionerRole), Reference(US Core Patient Profile), Reference(Device), Reference(RelatedPerson)	
📁 title		1..1	string	Document Title
📁 confidentiality		1..1	code	confidentiality
🟢 *attester*			*BackboneElement*	*Slice: Unordered, Open by value:mode*
📁 attester		0..1	BackboneElement	attester
📁 mode		1..1	code	mode **Fixed Value:** legal
↗ party		1..1	Reference(US Core Practitioner Profile)	party
📁 attester		0..*	BackboneElement	attester
📁 mode		1..*	code	mode **Fixed Value:** professional
↗ party		1..1	Reference(US Core Practitioner Profile)	party

US Core Framework

- Location
  - http://hl7.org/fhir/us/core/index.html
- FHIR Profiles for the Common Clinical Data Set (CCDS)
  - CCDS location:
  - https://www.healthit.gov/sites/default/files/2015Ed_CCG_CCDS.pdf

- US Core AllergyIntolerance Profile
- US Core CareTeam Profile
- US Core Condition (a.k.a Problem) Profile
- US Core Device Profile
- US Core DiagnosticReport Profile
- US Core Goal Profile
- US Core Immunization Profile
- US Core Location Profile
- US Core Medication Profile
- US Core MedicationRequest Profile
- US Core MedicationStatement Profile
- US Core Practitioner Profile
- US Core Procedure Profile
- US Core Results Profile
- US Core Smoking Status Profile
- US Core CarePlan Profile
- US Core Organization Core Profile
- US Core Patient Profile

US Core adopts the Vitals Signs Profile from FHIR Core.

Key US Core Profiles Used in the US Realm Header

- Patient

- Practitioner

- Organization

US Core Patient

Name	Flags	Card.	Type
📁 Patient		0..*	
⬡ identifier	S	1..*	Identifier
▭ system	S	1..1	uri
▭ value	S	1..1	string
⬡ name	S	1..*	HumanName
▭ family	S	1..1	string
▭ given	S	1..*	string
▭ gender	S	1..1	code
▭ birthDate	S	0..1	date
⬡ ~~animal~~		~~0..0~~	
📁 communication	S	0..*	BackboneEleme
⬡ language	S	1..1	CodeableConce
✳ us-core-race	S	0..1	(Complex)
✳ us-core-ethnicity	S	0..1	(Complex)
⭐ us-core-birthsex	S	0..1	code

- Profile on the Patient resource
- Key Constraints
  - Birth date
  - Communication
  - Race/ethnicity
  - Birth sex

US Core Practitioner

Name	Flags	Card.	Type
📁 Practitioner		0..*	
⬡ identifier	**S**	1..*	Identifier
▭ system	**S**	1..1	uri
▭ value	**S**	1..1	string
⬡ name	**S**	1..1	HumanName
▭ family	**S**	1..1	string

- Profile on the Practitioner resource
- Key Constraints
  - Identifier
  - Name
- For identifier, NPI is preferred, but a tax id and local ids are also allowed.

US Core Organization

Name	Flags	Card.	Type
📁 Organization		0..*	
🔶 identifier	S	1..*	Identifier
▭ active	S	1..1	boolean
▭ name	S	1..1	string
🔶 telecom	S	1..*	ContactPoint
🔶 address	S	1..*	Address
▭ line	S	0..*	string
▭ city	S	0..1	string
▭ state	S	0..1	string
▭ postalCode	S	0..1	string
↗ endpoint	S	0..*	Reference(Endpoint)

- Profile on the Organization resource
- Key Constraints
  - Identifier
  - Organization status
  - Name
  - Contact info
  - Address
  - Endpoint info (for web services)

C-CDA on FHIR Extensions

- **Adds features missing from Composition and needed for the C-CDA use case**

- **Some may eventually be added to Composition if the use case proves to be general (and international) enough**

- Data Enterer
  - US Core Practitioner
- Informant
  - US Core Practitioner
- Information Recipient
  - US Core Practitioner
- Participant
  - RelatedPerson
- Performer
  - US Core Practitioner
- Authorization
  - Contract

Document Types

- **Based on the US Realm Header**

- **Each adds additional constraints specific to that document type**

- **Each defines the legal sections and coded data for that document type**

- Care Plan
- Continuity of Care Document (CCD)
- Consultation Note
- Diagnostic Imaging Report
- Discharge Summary
- History and Physical
- Operative Note
- Procedure Note
- Progress Note
- Referral Note
- Transfer Summary

CCD Overview

- Most common document type in C-CDA (the CDA-based standard)

- Expected to be highly prevalent in C-CDA on FHIR

- Is a summary document type, intended for transfer of care scenarios

- Is often overused as a kind of "EHR data dump"

  - Who wants to read a 60 page "summary"?

CCD Header

- Inherits from the US Realm Header

- Binds type to 34133-9 (Summarization of Episode Note) from LOINC

- Requires event to be present (the period of care being summarized)

Name	Flags	Card.	Type	Description & Constraints
Composition		0..*		
├── type		1..1	CodeableConcept	Summary of episode note **Required Pattern:** {"coding": [{"system":"http://loinc.org","code":"34133-9"}]}
├── event		1..1	BackboneElement	serviceEvent
│ ├── code		0..*	CodeableConcept	code **Required Pattern:** {"coding": [{"system":"urn:oid:2.16.840.1.113883.5.6","code":"PCPR"}]}
│ └── period		1..1	Period	period
│ ├── start		1..1	dateTime	start
│ └── end		1..1	dateTime	end

CCD Sections

Required

- Allergies and Intolerances
- Medications
- Problems
- Results
- Vital Signs
- Social History

Optional

- Procedures
- Advance Directives
- Encounters
- Family History
- Functional Status
- Immunizations
- Nutrition
- Mental Status
- Plan of Treatment
- Payers
- Medical Equipment

Profiles Used in CCD Sections

- US Core Allergies
- US Core Medication Statement
- US Core Condition
- US Core Procedure
- US Core Result
- US Core Immunization
- US Core Vital Signs
- US Core Smoking Status Observation

- Also other unprofiled resources such as Observation, Encounter, etc.

C-CDA on FHIR Demo

- Live walkthrough of the specification
- Composition profiles and US Core

C-CDA on FHIR Timeline

- Sept 2016 "For Comment" ballot completed
  - Ballot reconciliation finished Dec 2016
- First STU ballot in January 2017
- Final publication of first STU April 2018 (completed)
- C-CDA to FHIR Mapping project will begin updating C-CDA on FHIR in late 2018.

Converting between C-CDA and C-CDA on FHIR

- **Why?**
  - ➢ Quick way to get a critical mass of FHIR documents
  - ➢ Continuity with existing practice, using better syntax and APIs
  - ➢ Creating FHIR documents and converting to CDA may be an easier way for developers to comply with today's regulations

Argonaut C-CDA to FHIR Mappings

- For analysis, not computable mappings

- Series of Google spreadsheets, one for each major section of C-CDA

- CDA Header's for various document types not included

- Pre-FHIR DSTU2

- Leveraged by the C-CDA on FHIR

- http://tinyurl.com/zhj2u9s

Argonaut C-CDA to FHIR Mappings

An Argonaut Mapping Spreadsheet

	A	B	C	D	E
	fx	FHIR Mapping using Observation			
1	**FHIR Mapping using Observation**	**Fixed value(s)/FHIR Value Set**	XPath	Card.	Verb
2	Observation		observation (identifier: urn:oid:2.16.840.1.113883.10.20.22.4.2)		
3	-		@classCode	1..1	SHALL
4	-		@moodCode	1..1	SHALL
5	-		templateId	1..1	SHALL
6	-		@root	1..1	SHALL
7	Observation.identifier		id	1..*	SHALL
8	Observation.code		code	1..1	SHALL
9	Observation.text		text	0..1	SHOULD
10	-		reference	0..1	SHOULD
11	-		@value	0..1	SHOULD
12	Observation.status	(FHIR) = http://hl7.org/fhir/vs/obse	statusCode	1..1	SHALL
13	-		@code	1..1	SHALL
14	Observation.applied[x]		effectiveTime	1..1	SHALL

Other Mapping Sources

- CDA Mappings in Individual Resources
  - ➤ Click the Mappings tab on a Resource page
  - ➤ Scroll down and look for CDA mappings
- CDA Logical Model and StructureMaps
  - ➤ Expresses CDA as a FHIR Logical Model
  - ➤ Allows StructureMap to be used for conversion

Composition	ClinicalDocument
(meta.profile)	ClinicalDocument.templateId
(language)	ClinicalDocument.languageCode
identifier	.setId
status	n/a
type	.code
class	n/a
subject	.recordTarget
encounter	.componentOf.encompassingEncounter
date	.effectiveTime
author	.author.assignedAuthor
title	.title
confidentiality	.confidentialityCode
attester	.authenticator/.legalAuthenticator
mode	implied by .authenticator/.legalAuthenticator
time	.authenticator.time
party	.authenticator.assignedEnttty
custodian	.custodian.assignedCustodian

CDA Header to Composition
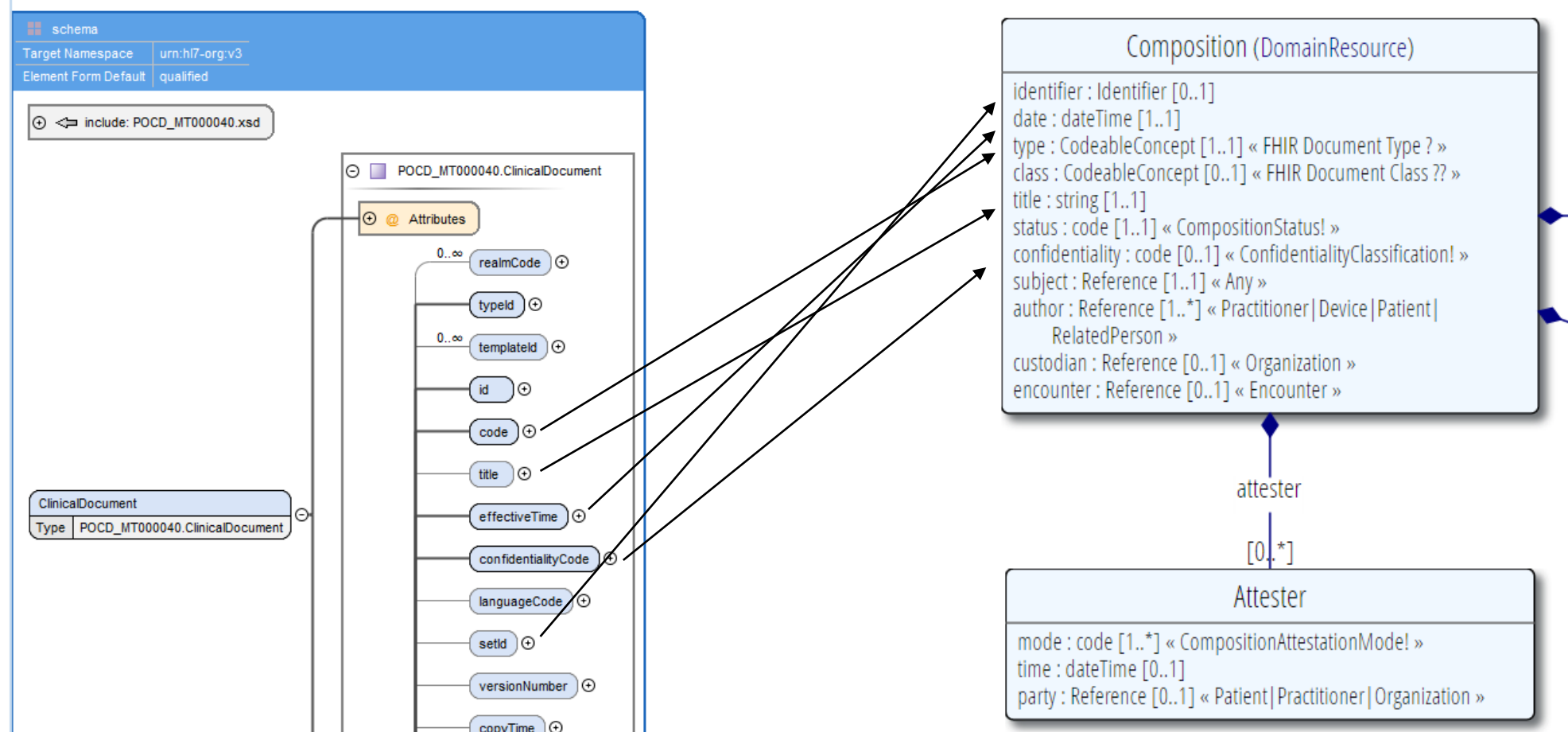
CDA Header to Composition Details

- Seems straightforward at first…

- Actual mapping is spread across multiple resources (Bundle, Composition, Patient, Practitioner, etc.)

- Some data don't map to core FHIR

  ➤ Unnecessary for your use case?

  ➤ Need realm specific extensions?

- Some data doesn't exist in CDA

  ➤ Composition.status

  ➤ Need appropriate defaults

Sections

- Section mapping is fairly straightforward.
  - Not much to do here but minor renaming (section.code to section.type, etc.)
- Both CDA and FHIR documents allow recursive sections.
  - But section nesting is pretty rare in practice (at least in US Realm CDA documents)

Converting CDA Narrative Content

- CDA markup is not XHTML

- However, the CDA.xsl contains the basic mappings from CDA narrative to XHTML

- Decide how much styling you want to add
  - The FHIR rendering stylesheet currently displays only the XHTML of any given resource
  - You may need more formatting in your narrative than you would in CDA for good looking documents

Populating Composition.text

- Everything you want rendered from the CDA Header, except the Patient
  - Title, type, author, attester, etc.
- Remember the rules for rendering FHIR documents:
  - Patient
  - Composition.text
  - Composition.Section.text
  - This is a SHOULD constraint, but the default stylesheet applies this order

CDA vs. FHIR Context Conduction

- **CDA**
  - Hierarchical structure
  - Association through nested constructs
  - Context conducts through the hierarchy
  - Set once in the header, applies to everything that follows unless overridden

- **FHIR**
  - Flat structure
  - Association through references
  - Context must be set explicitly in each resource

Converting Coded Entries

- **Templates to resources**
  - Use mappings where available
    - Note Argonaut mappings are pre-DSTU2
    - Be aware that moodCodes can impact this (supply/@moodCode=RQO maps to MedicationRequest, not MedicationDispense)
  - Conform to profiles if applicable/available
    - US Realm use US Core
- **Nested entryRelationships become references to discrete resources or just get merged into a single resource**
- **Need to explicitly define context for each resource**

Converting Datatypes

- **Mostly mechanical mappings**
  - @code → value
  - @codeSystem → system
- **OID to URI mappings**
  - 2.16.840.1.113883.6.1 to urn:oid:2.16.840.1.113883.6.1 works but
  - 2.16.840.1.113883.6.1 to http://loinc.org is much better
- **CDA Logical Model and StructureMap resources**
  - Lots of good mapping detail

Terminology Mapping

- The elephant in the room
- Use ConceptMap resources where they exist; build them where they don't
  - Can get very expensive when local codes are involved
- Commercial Terminology Service?
- Decide if all that coding is really necessary
  - Maybe plain text is good enough for your use case

Bundling It All Up

- **Do it yourself.**
  - Conversion code creates the Bundle resource.
  - Need to make sure that type=document, Bundle.identifier is globally unique, all references are contained in the Bundle, etc.

- **Let a FHIR server do it for you.**
  - POST the Composition and other resources to a FHIR server as you are converting, then just call $document at the end.
  - Side benefit: incremental validation
  - Downside: may not contain all the resources you want

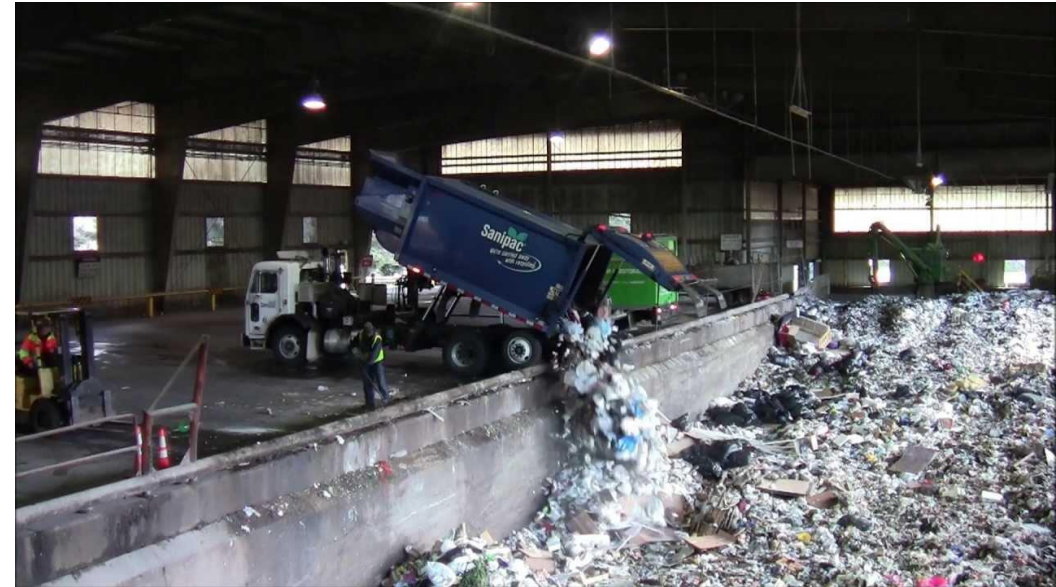# When things go wrong…

What you expect

What you get

CDA Quality Report (QRDA-I) Submission Statistics

Submission Year	Total Files	Files that passed validation	Successful Submitters
2014	237097	54795	14
2015 (partial)	82481	4495	17

77% of submissions were invalid in 2014, and 95% at the start of 2015 after minor implementation guide changes

But hope is not lost...

- More like a recycling center than a dump
- Many validation errors are minor and easily correctable
  - Old template IDs
  - Whitespace where not allowed
  - Misnamed attributes (displayname vs. displayName)
  - Missing classCode and typeCode
  - Missing elements that can be nulled
  - Knowing the target (document level templateId), you know the intent and can often apply corrections.
- Others are more difficult
  - Local codes instead of those required by C-CDA

Real-World CDA to FHIR Conversion

- The amount of pre/post processing will depend on many factors, such as the quality of input data and the capabilities of your transformation tools.

- You may need separate pre-processors for each source system.

- Whatever you do, don't forget to validate both input and output so you know what you are getting and what you are producing.
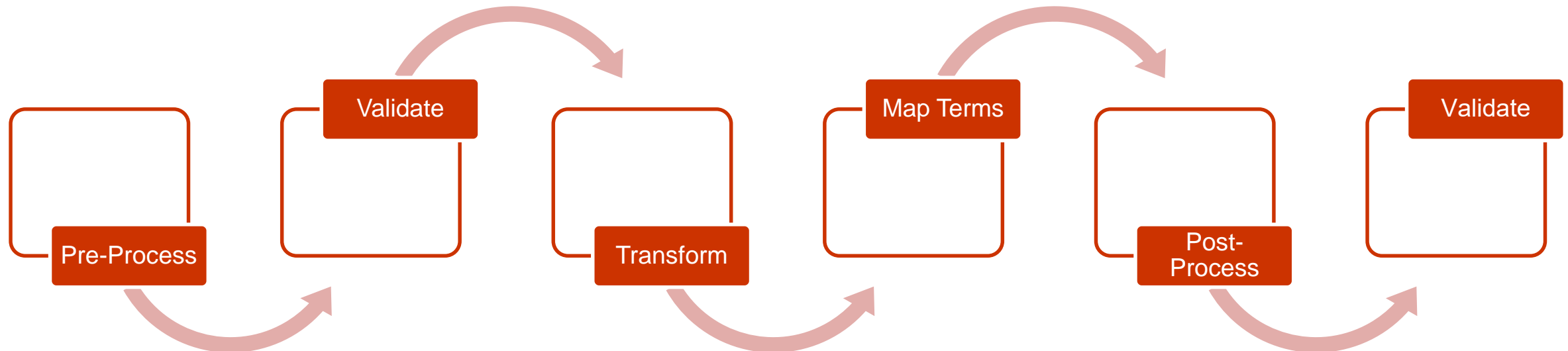
Going from FHIR to CDA

- Bundle = ClinicalDocument
- Composition = CDA Header + Sections
- Resources and Profiles become templates
- Rename fields
- Map data types
- References become nested elements
- XHTML to CDA narrative
  - Potential loss of some formatting
  - What to do with Composition.text?
- Lots of structural stuff to add
  - classCode, moodCode, etc.
- When in doubt, use the CDA Example Task Force data
  - http://wiki.hl7.org/index.php?title=CDA_Example_Task_Force

CDA Example Search Tool


```xml
<section>
    <!-- *** Allergies and Intolerances Section (entries required) (V3) *** -->
    <templateId root="2.16.840.1.113883.10.20.22.2.6.1"/>
    <templateId root="2.16.840.1.113883.10.20.22.2.6.1" extension="2015-08-01"/>
    <code code="48765-2" codeSystem="2.16.840.1.113883.6.1" codeSystemName="LOINC"/>
    <title>ALLERGIES AND ADVERSE REACTIONS</title>
    <text>No Known Allergies</text>
    <entry typeCode="DRIV">
        <!-- Allergy Concern Act -->
        <act classCode="ACT" moodCode="EVN">
            <templateId root="2.16.840.1.113883.10.20.22.4.30"/>
            <templateId root="2.16.840.1.113883.10.20.22.4.30" extension="2015-08-01"/>
            <id root="36e3e930-7b14-11db-9fe1-0800200c9a66"/>
            <!-- SDWG supports 48765-2 or CONC in the code element -->
            <code code="CONC" codeSystem="2.16.840.1.113883.5.6"/>
            <statusCode code="active"/>
            <!--currently tracked concerns are active concerns-->
            <effectiveTime>
                <low value="20100103"/>
                <!--show time when the concern first began being tracked-->
            </effectiveTime>
```

search criteria

search criteria

ente

no known allergies

This section has 1 exam

Name

Al

All

No Known Allergies
This is an example of ho

Ca

Pr

Encounters
Encounter Section Examples from C-C

Family History
Family History Section Examples from

http://cdasearch.hl7.org/

Investing in Information

- Clinical documents can be simple
- Clinical documents can be complex
- Simple encoding relatively inexpensive
- Complex encoding costs more
- You get what you pay for:
  - like charging a battery,
  - the more detailed the encoding
  - the greater the potential for reuse

Investing in Information: Phased Approach

- Lay groundwork
  - Composition resource metadata
  - Human readable sections
- Build
  - Consensus on requirements
    - Understand the resource profiling process
  - Vocabulary glossary
- Understand
  - Relationship of vocabulary to model
- Introduce interoperable semantic content as requirements and business drivers dictate

Managing FHIR Documents

- Documents are persistent objects
- Thus they must be stored somewhere (or reproduced exactly on demand)
- Options:
  - FHIR server (/Bundle or /Binary endpoint)
  - Document management system
  - Clinical data repository
  - Database
  - File system
  - etc.
- **Important:** documents cannot be generated, transmitted, then disposed of like an message. They are a persistent part of the patient record.

Validating FHIR Documents

- **FHIR validation pack**
  - Includes XML Schema and Schematron files
  - http://hl7.org/fhir/fhir-all-xsd.zip
  - FHIR Validator (Java Tool)
  - http://hl7.org/fhir/validator.zip
- **FHIR server validation**
  - Most servers to basic resource validation (Grahame's server if the strictest)
  - Use the $validate operation
    - Can validate profiles like C-CDA on FHIR
    - http://hl7.org/fhir/operation-resource-validate.html

Future Work

- Unstructured Documents (US Core DocumentReference profile)
- Section entry profiles not covered by US Core
- Other CDA IGs as driven by demand
- C-CDA to FHIR Mapping Project
    - Promises C-CDA to FHIR Mappings using FHIR Mapping Language
    - In progress, planned to finish by end of 2019

Is your roadmap on FHIR?

- FHIR evaporates "V3 messaging"
- V2: if not broke… don't replace
- CDA
  - FHIR retains CDA document concepts
  - Improves text/data management
  - Unified model/syntax with messages/API
  - C-CDA on FHIR ready for pilot use, limited production, but needs more testing/implementation

How do you get there from here?

- **Vision**: A future standards landscape where
  - Clinical documents and APIs share a common syntax and set of resources
  - Data can be acquired through an API and incorporated into a document or pulled from a document and made available in an API

Getting Involved

- C-CDA on FHIR weekly calls
- Volunteer to help with changes
- Continuous testing
- Connectathons

FHIR Connectathons

- Live software coding events where FHIR applications (and the standard itself) are tested.

- The FHIR Documents track tests C-CDA on FHIR and FHIR documents in general.

Resources

- **The FHIR spec:**
  - Updated continuously
  - URLs
    - Latest balloted version: http://hl7.org/fhir
    - Continuous build: http://build.fhir.org/
- **Lantana White Paper co-authored with Grahame Grieve:**
  - FHIR CDA Position Statement and Roadmap
  - Updated April, 2015
  - URL: http://www.lantanagroup.com/resources/publications/
- **Rick:**
  - Updated continuously, rebooted occasionally
  - rick.geimer@lantanagroup.com

Questions?