

Development And Testing Strategies

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Who am I?

- Grahame Grieve
- FHIR Product Director
- Health Interoperability Consultant



Learning Objectives

- What features FHIR has that support Product Development and Application Testing
- What challenges you are likely to run into
- What opportunities there are for further development in the FHIR Specification or Tooling eco-system

The Layers of FHIR



Storage

Question whether to use FHIR for Storage

- <https://www.youtube.com/watch?v=qhHyLadMxrM>
- <http://www.healthintersections.com.au/?p=2776>

Questions around multiple versions

- <https://www.youtube.com/watch?v=sOLaArLjX2E>

FHIR: Platform + Profiles (Implementation Guides)

- Platform:
 - “Base FHIR”
 - All the type definitions – Data Types and Resources
 - The way definitions work (StructureDefinitions + ValueSets, CodeSystems)
- Profile
 - A set of rules about how to use a resource
 - Resource may declare the profile, but may be subject to the profile even if it doesn't
 - Always provided as StructureDefinition + ValueSets, CodeSystems

Reference Implementations

- Focused on the platform – implement the types correctly
- Most include:
 - Object models (wire format independence)
 - Parsers
 - Utilities for dealing with object models
 - Client
- Some include:
 - Smart App launch support
 - Visual Widgets
 - Validator

Reference Implementations

- Java: <https://github.com/jamesagnew/hapi-fhir>
- DotNet: <https://github.com/FirelyTeam/fhir-net-api>
- Javascript: (<https://github.com/FHIR/fhir.js>)
- Python: <https://github.com/smart-on-fhir/client-py>
- Pascal: <http://github.com/grahamegrieve/fhirserver>
- Swift: <https://github.com/smart-on-fhir/Swift-FHIR>
- Dart: <https://pub.dev/packages/fhir>

Generating Object Code (AST)

The FHIR Specification provides a number of possible sources for generating Object Code

- Structure Definitions (master)
- XML Schema (variant schema)
- JSON Schema (trouble 😞)
- Excel Definitions (deprecated)
- RDF definitions (obscure)

All these are about generating the Platform Types & Resources

What about Profiles?

- Common Question: Can you generate for profiles?
- Not an easy question to answer:
 - A profile is a set of rules (e.g. code must be X, status must be Y)
 - A resource can conform to the rules, without telling you (common)
 - A resource can conform to multiple different profiles (including ones not yet defined)
 - A profile is not a type. Code generation always generates **types**
- Possible routes to code generation:
 - Generate Facades (attach to the underlying resource). *HAPI To do*
 - Generate Factory code (custom constructors)

Strategies for Working with Resources

Populating Resources:

- Fill out as much information as possible, even if not required
- When writing extensions, do the homework (search / declare)
- Validate resources – full validation

Strategies for Working with Resources

When Reading Resources

- Only validate the elements you depend on (business specific validation)
- Offer users choice to see the narrative (clinical safety check)
- Pay particular attention to Markdown and XHTML security issues
- Check your reading code using offensive resources

Strategies for Working with Resources

Designing Profiles:

- Say as little as possible (ignore fields you don't care about – depends on purpose)
- Invest in terminology
- Try for shallow profiles (depth → complexity / fragility)

FHIR & Clinical Safety

- Use the FHIR Safety Checklist <https://www.hl7.org/fhir/safety.html>
- Built the hard way: watching people make mistakes
- 42 check items
 - Some items may not be relevant to you
 - Because of the kind of implementation, or the features you use
- But some you wouldn't have thought of will be

Transport: RESTful API

- CapabilityStatement
 - SearchParameter
 - OperationDefinition
-
- Specify what API options are supported, and provide documentation

Code Generation Options

- Can code generate / automatically implement Search Parameters
 - Most general purpose servers do (R3+)
 - Can't do that if you're not a general purpose server
 - Chained Search Parameters are where the pain is
- Can't code generate Operation Definitions
 - Can code generate parameter objects
- Can't code generate CapabilityStatement API operations
 - Might be able to generalise across different resources

Multiple Implementation Guides

So you have to implement multiple IGs...

- Mostly, a client is task focused – one IG
- Can you have one server?
- Do you need one server that knows what flavor is in use?
- Or do you need one server per implementation guide
- In principle, one server should be possible, and is the goal
- But the devil is in the details – are the rules compatible?
- There is some tooling to compare IGs, but no binary answer

General Purpose Servers & Custom Servers

- General Purpose Servers
 - HAPI (+ SmileCDR)
 - Firely FHIR Server
 - AID Box
 - Microsoft FHIR Server
 - IBM FHIR Server
 - Google FHIR Server
 - Lots more....
- Custom Servers
 - Load a particular IG, and express that as a server
 - ...I Don't have a list.

Other kinds of development tools

- Public Registries
- Validator
- Terminology Server
- Visual Resource Editor / Designer
- Example Data
- Specification Publication
- Data Mapping Tooling
- Testing Platform

Public Registries

- <https://registry.fhir.org/>
- <https://simplifier.net/packages> (<http://packages.fhir.org/>)
- <http://www.fhir.org/guides/registry/>

- Specification registries
 - <http://hl7.org/fhir/directory.html> – all versions of FHIR
 - <https://www.hl7.org/fhir/us/> - all US specifications
 - <https://www.hl7.org/fhir/uv/> - all international specifications
- Apps: <https://apps.smarthealthit.org/apps/featured>

Validator

Java

- <http://validator.fhir.org>
- Or <https://github.com/hapifhir/org.hl7.fhir.core/releases>
 - (see <https://confluence.hl7.org/display/FHIR/Using+the+FHIR+Validator>)

DotNet

- <https://simplifier.net/validate>
- <https://simplifier.net/downloads/firely-terminal>

Test Cases: <https://github.com/FHIR/fhir-test-cases>

Terminology Server

Services:

- Value Set validation + expansion
- Code validation + look up
- Translation between code systems

Examples:

- <http://tx.fhir.org>
- Ontoserver
- Apelon DTS Server

Visual Resource Editor / Designer

- Design time editors – IDE types
- There's a few tools around
 - Snapper <https://ontoserver.csiro.au/snapper>
 - LHC Form Builder <https://lforms-formbuilder.nlm.nih.gov/>
 - FHIR Toolbox <http://www.healthintersections.com.au/FhirServer/>
 - Notepad++ plug-in
- No ambition to write a combined IDE

Example Data

- Synthea - <https://synthea.mitre.org/>
 - Download <https://synthea.mitre.org/downloads>
 - R3 / R4 generated sample data – realistic scenarios
- MIMIC data set. Full Data set requires NDA, permission
- Example data package fhir.test.data – r2 / r3 / r4
 - 100 real patient data from a set of deidentified CCDA documents

Specification Publication

Implementation Guide Publication

- FHIR IG Publisher (back end tool, can use directly)
 - <https://confluence.hl7.org/display/FHIR/IG+Publisher+Documentation>
- FHIR Shorthand (<https://github.com/FHIR/sushi>)
- Simplifier (<https://simplifier.net/>)
- Trifolia on FHIR (https://trifolia-fhir.lantanagroup.com/lantana_hapi_r4/home)

- Can use for internal/commercial specification development

Data Mapping Tooling

- FHIR Mapping Language (portable data mapping language)
- General purpose mapping tooling
- Lots of niche data mapping tools
 - V2 -> FHIR
 - CDA <-> FHIR

Testing Your Server : Testing Services

Test using external test system

- Inferno (<https://inferno.healthit.gov/>)
 - US Core
 - Bulk Data
 - Smart App
 - IPS
 - You can contribute...
- Aegis Touchstone (<http://www.touchstone.com/>)
- Mitre Crucible (<https://www.projectcrucible.org/>)
- Apple System tests

Testing Your Server : TestScript

- Write tests and publish them using Test Script resource
- Used inside Touchstone
- You can write your own Test Script
- Some implementation guides publish Test Cases
 - Generally worked up with Touchstone
- Or should you use a classic RESTful testing tool?
 - SmartBear?

Testing Issues

- To test, the server needs to have test patients
 - No standard way for the server to specify ids of test patients
- Also needs test accounts
- Do you anticipate running system tests on site?
- Hard to test an eco-system
- Hospitals routinely test on the live system
 - Implement a test mode? A test flag?
- Can run custom users tests in automated test

Testing Servers

- Always test security
- Automate your security tests. Then don't trust them

Summary

- Its up the server how much referential integrity to enforce
 - Almost all servers need some, almost no servers need everything
- Clients and servers need to document their expectations
- The API allows servers to enforce integrity
 - Clear error messages are useful
- The corner cases are very messy

Q&A

- During DevDays, you can find / reach me here:
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