FHIR Profiling – Overview & Introduction

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Who am I?

- Name: Michel Rutten
- Company: Firely, Amsterdam
- Background:
  - 1st Hello World on Philips P2000-T around 1982
  - Professional software developer since 1998
  - Microsoft .NET; Healthcare industries
  - Technical Specialist at Furore since May 2014
  - Member of the Firely FHIR development team
  - Specialized in FHIR Profiling & Conformance
  - Lead developer of Forge, the FHIR Profiling Editor
Topics

1. The need for profiling
2. FHIR Conformance layer
3. Profiles
4. Extensions
5. Packages
6. Implementation Guides
7. Registry
FHIR Profiling - Overview and Introduction

1. The need for profiling
Why do we need profiling?

• Many different contexts in healthcare, but only a single set of resources
• FHIR provides a platform specification
• Requires further adaptation to context of use
Profiling

Describe adaptations based on use & context:
• Which resources & elements are used?
• Which API features are used?
• Which terminologies are used?
• How to map these to local requirements?
Profiling

Allow for these usage statements:

• To be authored in a **structured** manner
  • Independent of serialization format
• To be published in a repository
• To drive validation, code generation etc.
FHIR Profiling - Overview and Introduction

2. FHIR Conformance layer
StructureDefinition

Defines data structures:
• Core datatypes
• Core resources
• Constraints on resources/datatypes
• Extensions
• Logical Models
StructureDefinition

- Publish to repository/registry
- Compare
- Transform
- Validate resource
- Generate code
- Generate UI

- Computable!
OperationDefinition

- Defines REST interactions
  - Name of the operation
  - Input/output parameters
  - Behavior
  - Works on which resources?
- Extend/restrict the API

- Computable!
SearchParameter

• Defines named search parameters for REST API
  • Name
  • Interpretation?
  • Supports which resources?
  • Matches which resource elements?
  • Extend/restrict the API

• Computable!
**CapabilityStatement**

Defines capabilities of a FHIR server

Binds all conformance resources together

Usage:

• Advertise supported capabilities
• Describe required capabilities

• **Computable!**
CapabilityStatement

Defines supported:
• Serialization formats
• Security services
• Operations
• Search Parameters
• Resources
• Profiles
ImplementationGuide

• Defines scope of usage
• Describes requirements for a FHIR implementation
• Specifies links to:
  • Relevant FHIR artifacts (profiles, IGs)
  • Editorial content (documentation)
• Usage:
  • Publish an implementation guide
  • Validate conformance
• Computable!
FHIR Conformance Module
Used to define the FHIR core spec

- Core datatypes
- Core resources
- Standard REST operations
- Standard search parameters
- Standard terminology

_bootstrap

Eat Your Own Dogfood
Canonical Url

• **Unique identifier** for a conformance resource (uri)
  • Author-assigned
  • Shared by all instances
  • Reference to a conformance resource
• Cf. Resource Id
  • Server-assigned
  • Unique per instance
• Example:
  [http://hl7.org/fhir/StructureDefinition/Patient](http://hl7.org/fhir/StructureDefinition/Patient)
## Canonical Url

<table>
<thead>
<tr>
<th>EU Server</th>
<th>US Server</th>
<th>Asia Server</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td>AcmePatient</td>
<td></td>
</tr>
<tr>
<td>** Canonical**</td>
<td><a href="http://acme.com/fhir/StructureDefinition/acme-patient">http://acme.com/fhir/StructureDefinition/acme-patient</a></td>
<td></td>
</tr>
<tr>
<td><strong>Resource Id</strong></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
3. Profiles
Profile

Define constraints on:
• A FHIR core datatype
• A FHIR core resource
• Another FHIR profile

Also used loosely to refer to:
• An implementation guide
• A conformance package

What is the difference between a resource and a datatype?
Layered Profiles

Core Profiles
National Profiles
Regional Profiles
Organizational Profiles

All resources
National resources
Regional resources
Organizational resources

More specific
More generic
Volume
Conform to
StructureDefinition

Metadata:
• Canonical url
• Name, Title
• Status (draft, active)
• Date, Version (author assigned)
• Author, publisher, contact, ...
• Base profile
StructureDefinition

List of ElementDefinitions:
• Name, cardinality, data type
• Definitions, usage notes, requirements
• Default or fixed values
• Complex constraints, length limits
• Terminology bindings
• Mappings to other specifications
Complex constraints

<table>
<thead>
<tr>
<th>XPath</th>
<th>FHIR Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHIR DSTU1</td>
<td>FHIR DSTU2+</td>
</tr>
<tr>
<td>XML Query Language</td>
<td>Graph traversal language (hl7.org/fhirpath)</td>
</tr>
<tr>
<td>Only supports XML</td>
<td>Independent of serialization format; supports XML, JSON, RDF, ...</td>
</tr>
<tr>
<td>Tightly bound to XML</td>
<td>Independent of model; supports FHIR, V3, CIMI, QDM, ...</td>
</tr>
<tr>
<td>Hard to express e.g. FHIR slicing (write-only)</td>
<td>Fluent syntax; powerful, expressive and readable</td>
</tr>
</tbody>
</table>

Examples:

- `Patient.name.where(given = 'Wouter').exists()`
- `Observation.value.ofType(Quantity).unit`
- `MedicationAdministration.wasNotGiven implies MedicationAdministration.reasonNotGiven.exists()`
Referring to a profile

Observation Resource
- **Observation**
  - Cholesterol
- 6.3 mmol/L
- High

Observation Profile
- **StructureDefinition**
  - LDLCholesterol
  - url: http://acme.org/fhir/StructureDefinition/LDLCholesterol

Profile Tag
- I'm conforming to profile: http://acme.org/fhir/StructureDefinition/LDLCholesterol

Validate

Resolve
Versioning – non breaking change(s)

- Compatible
- Old data can still be
  - validated against new profile
  - Correctly interpreted against new profile
- Maintain same canonical url
- Bump author-assigned version
Versioning – breaking change(s)

- Incompatible with previous profile version
- Must assign **new** canonical url

Published profiles should be considered as *eternal contracts*
## Differential vs. Snapshot

<table>
<thead>
<tr>
<th>Differential component</th>
<th>Snapshot Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial list of definitions for elements constrained by this profile</td>
<td>Complete list of definitions for all elements in the datatype or resource</td>
</tr>
<tr>
<td>Specifies only constraints introduced by this profile</td>
<td>Specifies all constraints, incl. inherited from base</td>
</tr>
<tr>
<td>Authored by modeler</td>
<td>Computer-generated (FHIR Operation)</td>
</tr>
<tr>
<td>Relatively small (KBs)</td>
<td>Fairly large (MBs)</td>
</tr>
<tr>
<td>For efficient data interchange &amp; storage</td>
<td>For processing (validation, code generation, reporting etc.)</td>
</tr>
</tbody>
</table>
Authoring Profiles

• Manually author XML/JSON
• Excel (build tool)
• Lantana Trifolia Workbench [https://trifolia.lantanagroup.com/](https://trifolia.lantanagroup.com/)
• Forge [https://simplifier.net/forge/](https://simplifier.net/forge/)
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4. Extensions
Extensions

Allows to define and introduce custom elements

Example: Patient race, ethnicity

- Registration is mandatory in US
- Registration is illegal in EU
- Cannot be defined by the core Patient resource definition!
Defining an extension

• Defined by StructureDefinition resource
• Unique identifier: canonical url
• Define extension context
  • Where can this extension be used?
  • Target structure: Resource | Datatype | Extension
  • List of type names and/or element paths
• Reusable in many profiles
Using an extension in a resource

• By default, FHIR allows all resource elements to specify any number of extension elements
  • Inherited from Element.extension

• A profile can constrain the extension list of each resource element
  • Require/prohibit certain extensions
  • Disallow all extensions

• Extension elements in profiles refer to external extension definitions
  • Element.extension.url = <target canonical url>
Using extensions

Patient Instance

**Patient**
Irma Jongeneel-de Haas
...
Nationality: NL

Extension value in instance

Patient Profile

**StructureDefinition**
nl-core-patient
http://hl7.nl/fhir/StructureDefinition/nl-core-patient

Patient.name : HumanName
...
Patient.nationality : Extension(patient-nationality)

Conforms to profile

Extension Definition

**StructureDefinition**
Patient-nationality
http://hl7.org/fhir/StructureDefinition/patient-nationality

"code" : CodeableConcept
"period" : Period

Reference to external extension definition
Primitive Extensions

• Define a single custom element
• Constrain the type of the element value
  • Primitive value
  • Complex value

• Examples:
  • patient-birthTime (dateTime)
  • birthPlace (Address)
Complex Extension

• Define a set of related custom elements
  • Elements may be nested (subtree)
• Constrain the type of each element value

• Example: patient-nationality
  • code: CodeableConcept
  • period: Period

Gigawidget © Extension
5. Packages
FHIR Package

Set of conceptually related FHIR conformance resources:
• Structure Definitions (Profiles)
• Value Sets
• Operation Definitions
• Search Parameter Definitions
• Example Resources
• ...
FHIR Package Manager

- Manage FHIR packages
  - Find
  - Install
  - Upgrade
  - Configure
  - Remove
- Based on NPM
  - Node.js Package Manager
- Resolve canonical url to package
Dependencies

• A package can depend on other (external) packages
  • Example: FHIR STU3 Core Resource & Datatype definitions

• Package Manager – Install Package
  • Resolve all dependencies, recursively
  • Install/update to required package versions
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6. Implementation Guides
Implementation Guide Resource

• Define content structure
• References to external artifacts
  • Page content files
  • Images, CSS, JavaScript
• Supported page formats:
  • Markdown
  • HTML
Implementation Guide Resource

• Define conformance package(s)
  • Set of conceptually related artifacts
  • Based on FHIR NPM package

• Specify references to external artifacts
  • StructureDefinition
  • OperationDefinition
  • SearchParameter
  • ValueSet
  • Example resources
Implementation Guide Resource

- **Author**
  - Create manually or generate, e.g. from Simplifier
- **Exchange**
  - Inbetween IG authoring and/or publication environments
- **Publish**
  - To registry
  - Render content (website, PDF, print, ...)
  - cf. FHIR spec
Implementation Guides & FHIR Packages

• Implementation Guide
  • Provides human-readable information (narrative)
  • Contains formatted text, pictures, attachments, ...
  • Explains to developers how to implement a specific use case
  • Publish to local/online website or to PDF

• Package
  • Provides machine-readable information (computable)
  • Contains conformance resources
  • Allows machines to validate, generate code, generate UI, ...
  • Publish to FHIR Package server
Authoring Implementation Guides

IG Builder
• Official HL7 open source command line tool
• Can render IG resource as a website

Examples:
• FHIR specification
• DAF Argonaut
Authoring Implementation Guides

Simplifier

• Browse & find published IGs
• Supports online IG authoring & publication
• Embed rendered artifacts

Examples:
• HL7 Germany
• Devices on FHIR POCD
Authoring & Publication Workflows

- Create
- Collaborate
- Review
- Finalize
- Update

- Publish
- Unpublish
- Archive
- Update
- Distribute
- Final
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7. Registry
Official HL7 FHIR registries

• HL7 FHIR Profile registry
  • https://registry.fhir.org/
  • Find official profiles published by HL7 intl. & WG

• HL7 FHIR Implementation Guide registry
  • http://www.fhir.org/guides/registry
  • Browse official HL7 implementation guides
SIMPLIFIER.NET

• Public FHIR registry

• Search, browse & find FHIR conformance resources:
  • Profiles, IGs, Valuesets, Examples, ...

• Contains:
  • Official HL7 profiles
  • HL7 affiliate profiles
  • Private company profiles
  • Public user profiles

https://simplifier.net
- Validate examples against profiles
  - Are my example resources valid?
- Incoming & outgoing references
  - Who is depending on my profiles/extensions?
- Download statistics
  - How popular are my profiles?
- Official back-end for https://registry.fhir.org/
  - Publish from Simplifier to HL7 registry
Welcome to the Profiling Academy!

The Profiling Academy is an online training for FHIR profiling. The learning material consists of instructions, real-world examples and exercises. The Profiling Academy training is available for free to all FHIR profilers. Simplifier users and non-users alike. Learn more about FHIR profiling and start creating profiles today!

Short, digestible training modules

The Profiling Academy consists of short and digestible training modules. Each training module tackles one specific topic. Follow all training modules to learn all the ins and outs of FHIR profiling. Each module provides in this training starts with theory, followed by real-life examples. The modules end with exercises to support active learning. To ensure flawless implementations, the training modules also cover FHIR profiling best practices. Complete all training modules to become a FHIR profiling expert yourself.

Select a training module from the modules menu to learn more about a specific topic. Or click on one of the modules in the table below.

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<tr>
<th>Modules</th>
<th>Introduction to FHIR and profiling</th>
<th>Search operations and parameters</th>
<th>Publishing and validating your work</th>
<th>Advanced slicing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensions</td>
<td>SDC and questionnaires</td>
<td>Best-Practices</td>
<td>Advanced search operations</td>
<td></td>
</tr>
<tr>
<td>Start Profiling</td>
<td>FHIR mapping language</td>
<td>Profiling tools</td>
<td>Invariants</td>
<td></td>
</tr>
<tr>
<td>Slicing</td>
<td>Logical models</td>
<td>Get started with Simplifier</td>
<td>FHIR Messaging</td>
<td></td>
</tr>
<tr>
<td>Terminology</td>
<td>Contained resources</td>
<td></td>
<td>Documents</td>
<td></td>
</tr>
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Exercises...
FHIR Profiling Exercises

• Print outs available at the registration desk
  Download from https://www.fhirdevdays.com/exercises/

• Need help?
  Visit the profiling academy for more information: https://simplifier.net/guide/profilingacademy
Hey, careful man! There's a beverage here!

Coffee!