INTERWEAVE
CONNECTING CARE

Cookbook for Regional Interoperability
Detailed Design Paper #029

FHIR Metadata Management

PRELIMINARY DRAFT

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Abstract Interoperability Cookbook Anchor Points

Section	Title
6	FHIR Resource Profiles

Table of Contents

Version Control

Version	Release Date	Released By	Reason for Release
1.0	06/09/2020	Robert Hickingbotham	Preliminary Draft
1.1	01/09/2021	Tim Davey	Updated access and authentication details

Reviewers

Initials	Name	Role	Organisation

1 Introduction

1.1 Purpose of this Document

This document is one of a series of design papers which underpin the Abstract of a Cookbook for Regional Interoperability (the Abstract Cookbook). These papers, in their totality, describe the technical components and the standards which form the YHCR System of Systems (SoS). They are intended as a basis for developing or procuring software and so are expressed at a level of precision which aims to avoid ambiguity but consequentially, they are focussed to technical readers.

Design papers are anchored to topics which are discussed in the Abstract Cookbook. They are elaborations of the concepts which were first introduced by the abstract and new content is further detail rather than variations of previously established core principles.

This document (design paper 029 - “Metadata Management”) deals with the subject of profiling of FHIR Resources and is closely linked with the YHCR Maturity Model (design paper 023).

Typically, FHIR resources are very flexible and they can be used to model a variety of clinical concepts. A profile constrains a resource to a particular purpose. It is a more definitive determination of the data content of a resource than the raw resource definition on which it is based.

Constraining a resource means specifying through a refinement of the base resource definition more precise definitions of:

- the cardinality of individual properties, making, for instance, a property mandatory when according to the base definition it is optional;
- the detail of coding systems to be used for properties;
- attributes of properties such as maximum or minimum values;
- additional properties or extensions to the base resource.

This paper defines the technical componentry and processing which will be provided by the YHCR to support the process of profiling resources.

1.2 Use of FHIR Profiles in the YHCR

Profiles are used to inform data consumers that a data item complies with a defined standard. Pre-determination of a standard enables a data consumer to adapt the way that it interprets a data item. For example, a blood pressure measurement is expressed as a FHIR *Observation* resource. The base *Observation* resource allows any number of measurements to be associated with a single observation. A profile for blood pressure measurement constrains it to have exactly two measurements: a systolic pressure and a diastolic pressure. A user interface can rely on this structure and use it to graph blood pressure readings over time.

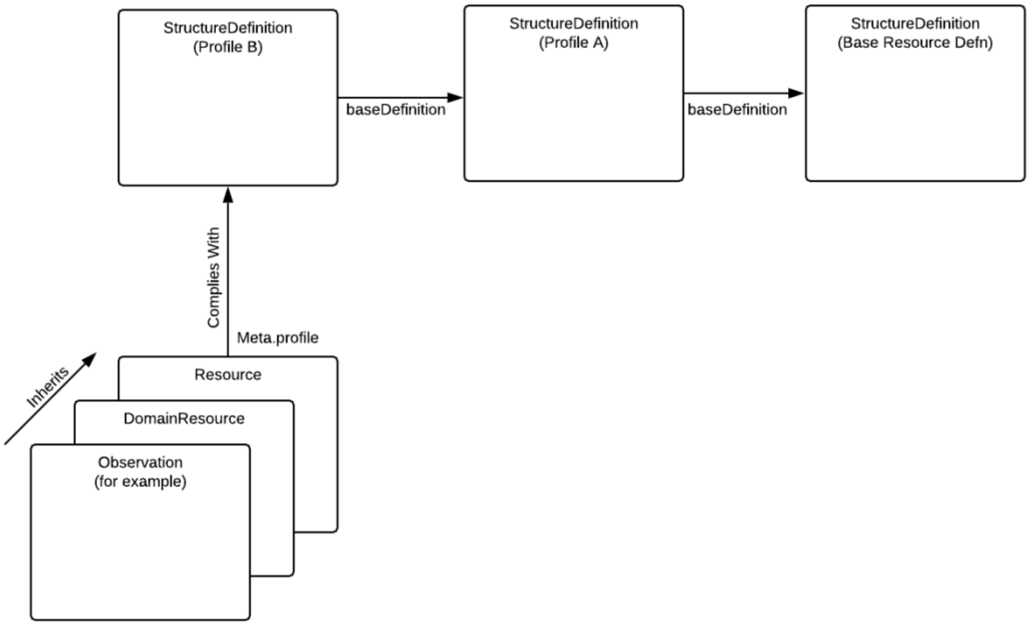
FHIR profiles can also be used to define levels in the YHCR maturity model. Consider for instance an *Appointment* resource. The base resource has an optional *serviceCategory* property that, if provided, offers a broad categorisation of the type of service to be provided. At a low level in the maturity model a data provider may not be expected to provide this and the base STU3 resource definition sufficiently defines the resource content. At an interim maturity level, a data provider may be expected to offer a textual description of the service category and profile makes this property mandatory. As the highest maturity level, a data provider might be expected to code the service category using SNOMED-CT and a further profile binds the property to the coding system.

1.3 Representing Profiles in FHIR

FHIR is self-describing in that resource structures and profiles can be expressed using FHIR resources. The *StructureDefinition* resource is used for this purpose.

FHIR resources can reference the URLs of the profiles to which it conforms. The URL points at a StructureDefinitions resource which can be served in a machine-readable format. A *StructureDefinition* can be a differential of another *StructureDefinition* and so only explain deviations from the base definition*,* alternatively it can fully specify a resource, it which case it is termed a specialization.

The model is illustrated below:



1.4 Metadata Management Requirements for the YHCR

Metadata management covers the process of developing and curating profiles, publishing computable representation of profiles, and using of profiles in validating and interpreting data content. Technical requirements for the YHCR supporting these processes distil to:

- Providing a repository in which YHCR developed FHIR profiles (*StructureDefinitions*) can be persisted.
- Supporting a mechanism for members of the Data Architecture Design Authority (DADA) to curate YHCR profiles;
- Validating FHIR resources exchanged through the SoS against the profiles with which they claim compliance.

Validation should be optional and will only be used in a live setting to diagnose problems. Validation against the FHIR resource definition was expressed in design paper 010 – "FHIR Aggregator Service" and this requirement extends the core capability.

Profiles used in the YHCR may be:

i. Published externally to the YHCR (i.e. Care Connect).
ii. Published by the YHCR as differentials from the base STU3 FHIR resource (or later FHIR resource version).
iii. Published by the YHCR as differentials internally or externally published profiles.

Metadata management places a requirement on data providers:

- a data provider which aligns its data to a level in the YHCR maturity model must reference the relevant profile in the Meta.profile property of resources is provides.

1.5 Relationship of this Document with Other Standards

This document assumes familiarity with the HL7 FHIR StU3 StructureDefinition:

- HL7 FHIR STU3 StructureDefinition.

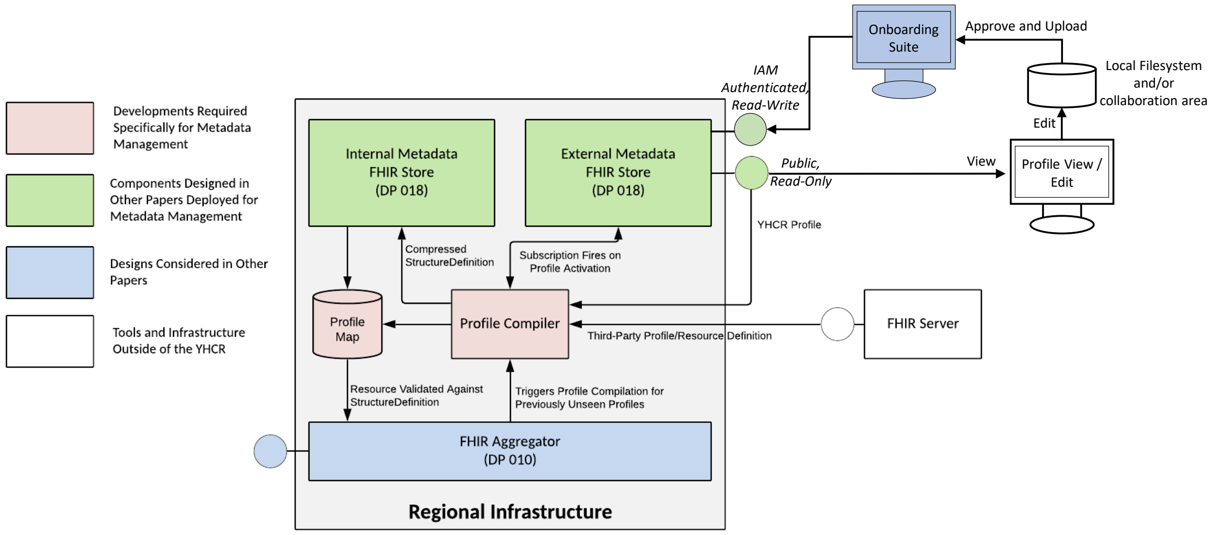
1.6 Intended Users of the This Document

Developers of the SoS core components and data providers.

2 Metadata Architecture

2.1 Overview

The following diagram illustrates the components of the Metadata architecture:


Developments Required Specifically for Metadata Management
Components Designed in Other Papers Deployed for Metadata Management
Designs Considered in Other Papers
Tools and Infrastructure Outside of the YHCR
Onboarding Suite
Approve and Upload
Local Filesystem and/or collaboration area
Edit
IAM Authenticated, Read-Write
Internal Metadata FHIR Store (DP 018)
External Metadata FHIR Store (DP 018)
Public, Read-Only
View
Profile View / Edit
YHCR Profile
Compressed StructureDefinition
Subscription Fires on Profile Activation
Profile Map
Profile Compiler
Third-Party Profile/Resource Definition
FHIR Server
Resource Validated Against StructureDefinition
Triggers Profile Compilation for Previously Unseen Profiles
FHIR Aggregator (DP 010)
Regional Infrastructure

The architecture centres around a regionally hosted Internal Metadata FHIR Store. This persists "compressed" version of FHIR profiles. A "compressed" profile is a *StructureDefinition* which is a specialisation of STU3 standard *DomainResource*: the base class for all FHIR resources. As a specialisation the *StructureDefinition* completely describes a resource and can be used to validate resource content in transit through the SoS FHIR Aggregator. Because the specialization is self-contained, validation can be performed solely using information held by the YHCR and so can be undertaken in-line with the FHIR Aggregator message pathway and invalid resources can be withheld from data consumers.

YHCR profiles are developed using standard off-the-shelf profile editors such as Forge, a tool which at the time of writing is free for non-commercial use. The profiles are persisted (as differential *StructureDefinition* resources) in a FHIR Store – the External Metadata FHIR Store.

Profiles under development are edited and collaborated on outside of the core infrastructure. When a profile is ratified by the DADA then it is uploaded via the Onboarding Suite.

A Profile Compiler uses a subscription to obtain notification about changes to active profiles. The subscription triggers a profile compression process.

Profile compression entails traversing the chain of differential profiles until a specialization (the base resource definition is located). Element definitions are copied from each differential to the specialization and a standalone structure definition is persisted in the regionally hosted Internal Metadata FHIR Store.

The YHCR may use profiles in its maturity model that are published by bodies other than the YHCR. Compression for these profiles is triggered either manually or by the FHIR Aggregator encountering an example of a profile in a resource transiting through it.

Metadata FHIR Stores and the Profile Compiler are hosted outside the SoS environments and are accessible by all environments. This arrangement ensures that the same profile definitions are used in Development, System Test, Sandpit, Staging and Live.

2.2 Metadata FHIR Stores

The internal and external Metadata servers are instances of a FHIR Store (design paper 018).

The internal server is accessible only from within an SoS environment (the same server is used by all environments), The external server is internet facing and can be accessed without authentication to read *StructureDefinition* resources and with authenticated access for creating and updating *StructureDefinition* resources.

Authenticated access is provided via the Onboarding Suite[1]. Users with a role of "FHIR Profile Editor" are able to perform file uploads of *StructureDefinition* resources into the external Metadata server.

- It is anticipated that this role will be granted to a small number of admin users, giving them authority to "approve" new *StructureDefinition* resources and upload them for active use by the system.
- Access for these admin users is controlled via the normal 2-factor logon process to the Onboarding Suite. The backend link between the Onboarding Suite and the metadata servers is secured using IAM tokens in the normal way.

2.3 Publishing FHIR Profiles

Profile editors such as Forge enable end-users with data modelling skills to define constraints over an existing resource definition or profile. The constraints are published to the external metadata server. Profiles are published in draft status.

DADA authorisation is required to activate the profile and this action is restricted to an authorised user. The change of status from draft to active triggers a subscription which in turn triggers execution of the Profile Compiler.

2.4 Compiling Profiles

The Profile Compiler compresses differentials into the base specialization to produce a single *StructureDefinition* which fully describes the profile. It iteratively retrieves *StructureDefinition* resources by traversing from a resource to the next through the resource's baseDefinition property. Resources are retrieved from publicly facing FHIR servers (including the YHCR external metadata server). Iteration is complete when a *StructureDefinition* is retrieved with a derivation of "specialization".

To compress the definitions the compiler works back from the specialisation through successive differentials and merges element definitions from the differential's "differential" array to the specialisation's "snapshot" array.

[1] It was originally envisaged that it might be possible to enable authenticated access directly from some of the profile editing tools such as Forge – thus allowing initial design and collaboration work to be done directly within the external metadata store. However in practice the necessary authentication mechanisms are not supported by the these tools at the current time. This idea may be revisited if the situation changes in future.

Element definitions are validated before application to ensure:

- differentials refer to the same resource type;
- cardinalities are not broadened;
- minimum or maximum values are not extended;
- maximum string lengths are not extended;
- required bindings to values sets are not redefined;
- element types are not changed.

Once the profile has been compressed then the resulting *StructureDefinition* is created in the internal metadata FHIR Store.

An association between the fully qualified profile URL and the resource id is persisted in a database, the Profile Map. This is accessible to FHIR Aggregators in all environments.

The Profile Compiler can be invoked by:

- an agent responding to subscriptions to changes to active *StructureDefinitions* in the external metadata FHIR Store;
- a FHIR Aggregator detecting a previously uncompiled profile;
- an operator request.

2.5 Validating Resources in Transit

A FHIR Aggregator can optionally validate a resource in transit on any message pathway for any interaction pattern. The requirement is specified by design paper 010 – "FHIR Aggregator". Validation is enabled by data source.

This functionality is used for metadata management as follows:

- if a resource does not claim compliance with a profile then it is validated against the resource's base *StructureDefinition*;
- if a resource claims compliance with a prtofile then the id of the associated *StructureDefinition* is determined from the Profile Map and the resource is validated against this.
- if an entry does not exist in the Profile Map then the Profile Compiler is invoked asynchronously, the resources passes without validation and the event is logged.

Allowing resources to pass unvalidated for previously unseen profiles is considered acceptable for the following reasons:

- it should be rare for a resource which is aligned with a profile hitherto unknown to the YHCR to pass through the live environment. All data sources will have been onboarded through a Sandpit and Staging environment and subject to user acceptance and clinical safety testing before entering live operation.
- validation will only be enabled in a live environment for diagnostic purposes. Log entries of the skipped validation are recorded and the resource occurrence can be investigated.

Appendix 1 – Maturity Matrix

Section	Narrative	Consultative	Draft	Normative
1 Introduction 1.1 Purpose of this Document	X			
1.2 Use of FHIR Profiles in the YHCR	X			
1.3 Representing Profiles in FHIR	X			
1.4 Metadata Management Requirements for the YHCR		X		
1.5 Relationship of this Document with Other Standards	X			
1.6 Intended Users of the This Document	X			
2 Metadata Architecture 2.1 Overview			X	
2.2 Metadata FHIR Stores			X	
2.3 Publishing FHIR Profiles			X	
2.4 Compiling Profiles			X	
2.5 Validating a Resource in Transit			X	