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# Towards Interoperability in Clinical Research: Enabling FHIR on the Open Source Research Platform XNAT

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### 1. Introduction

The FAIR guiding principles define interoperability as one of the main aspects of modern research [1]. To achieve this, standards for communication between systems and for different formats of data are employed. The Health Level Seven International organisation actively develops the HL7 standards for healthcare and research. Interfaces that comply to the suggested standards are already implemented in different platforms, such as Smart Health IT<sup>2</sup>, openEHR<sup>3</sup> or HiGHmed<sup>4</sup>.

*HL7 FHIR* The Fast Healthcare Interoperability Resources (FHIR) is a recent standard framework from HL7<sup>5</sup> developed for transferring medical data between heterogeneous platforms. The structured definition of all required datatypes for clinical routine and medical research combined with the specification of an open source XML and JSON data exchange format make HL7 FHIR a promising standard to adopt in medical information systems.

*XNAT* Since HL7 FHIR supports a RESTful architectural style, interoperability becomes achievable at the communication level, as many data management systems (DMS) implement a REST-API. Therefore, the Extensible Neuroimaging Archive Toolkit (XNAT) was chosen for the presented work. It is an open source data management platform developed at Washington University in St.Louis and widely used by biomedical imaging researchers to simplify management und productivity tasks for neuroimaging [2]. It is especially designed to be extended by any data models and formats [3]. With the latest XNAT version (1.7) we have employed both its REST-API and plugin capacities to fulfill the integration of a FHIR standard subset into the platform.

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<sup>&</sup>lt;sup>2</sup>https://smarthealthit.org/

<sup>&</sup>lt;sup>3</sup>https://www.openehr.org/

<sup>&</sup>lt;sup>4</sup>http://www.highmed.org/

<sup>&</sup>lt;sup>5</sup>http://www.hl7.org/

#### 2. Implementation

The recent release of the HL7 FHIR standard describes a total number of 891 datatypes with different levels of maturity like *normative*, *draft*, *trial use* or *informative*. For the presented work a subset of datatypes was selected. The chosen datatypes all relate to the management of patient data like e.g. name, gender, contacts, addresses.

XNAT already provides different data types defined via XML schema definitions (XSD). These predefined datatypes are e.g. *projects*, *subjects* and *experiments* which have a hierarchical relationship. To enable a compatible FHIR interface for patient data in XNAT, additional information must be handled by the system. This is realised through the creation of additional XSD files that describe data fields present in the FHIR specification but are missing in the XNAT datatypes. Finally the new patient related datatypes need to be integrated into the existing type hierarchy of XNAT and must be connected to the *subject* type. This is achieved by the new *FHIRPatient* type that is derived from the existing XNAT *subjectAccessorData* type.

To realize a HL7 FHIR compatible REST-API inside the XNAT system the plugin interface is employed. The plugin is build based on the provided XNAT development environment that consists of several JAVA-libraries and configuration files for the *gra-dle* build system. XNAT 1.7 is build upon the *Spring* web-framework and plugins can therefore use all capabilities that are present in its libraries. The plugins registers new endpoints for patient data in the REST interface. The XNAT/Spring routing mechanism invokes the plugin functionality upon access of the standardized web-endpoints.

All compiled source files that implement the new REST interface, datatype descriptions and files generated from the build system are integrated into a single *jar* file. This result file represents the plugin and is copied to the XNAT system where it is automatically extracted. Required changes to the database are persisted by the XNAT system itself.

#### Validation

The platform was validated with all available public patient resources (n=31) that were downloaded in JSON format <sup>6</sup>. In attempt to compare the functionality, it was patient files uploaded wia curl both in HAPI FHIR<sup>7</sup> (the FHIR API server) and XNAT.

The source code of this work is available at [4].

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<sup>&</sup>lt;sup>6</sup>http://hl7.org/fhir/2018Sep/downloads.html

<sup>&</sup>lt;sup>7</sup>http://hapifhir.io/

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