Philips **Health**Suite Hackathon: Cooking with FHIR

March 6th - 8th, 2015

PHILIPS

Cooking with FHIR 

Contents

The Ingredients

FHIR uses the concept of resources as first class objects. Each resource has a unique URI. The resources used in the **Health**Suite product are user, organization, patient, and observation.

User

A login operation will return the current user object and there are some important pieces that need to be extracted from a user resource such as this:


```
{
  "access_token": "krCoQ2NQyOGc6HEQb0XIKObwCJac",
  "expiresIn": 604800,
  "user": {
    "uuid": "f1cfcdfa-9397-11e4-ac8d-4dd11eccb16a",
    "type": "user",
    "name": "Henry Levins",
    "created": 1420324153423,
    "modified": 1421254447439,
    "username": "henry.levins",
    "email": "henry.levins@company.com",
    "activated": true,
    "picture": "http://www.gravatar.com/avatar/5954d36d0ebdd629f9bc62cf2a6cc5ef",
    "fhir_organization_id": "/Organization/phr",
    "fhir_patient_id": "/Patient/a100"
  }
}
```


The Important Bits

Throughout this cookbook we will try to identify and explain the most important parts of each resource, those items which will prove to be useful when querying, extracting, and processing health and wellness data.

access_token

The access model uses Oauth2 so this access token must be included in any REST call to the secure server (see login/logout).

fhir_organization_id

The fhir_organization_id identifies the organization to which the user belongs. The user can retrieve information about this organization and no other.

fhir_patient_id

The fhir_patient_id field identifies the patient associated with the current user. For patient logins, this is the only patient record the user can access.

Organization

The organization record can be very simple, at minimum containing the name and identifier, but it can also include contact information, location, and even hierarchy. For a full description of the Organization resource, see http://www.hl7.org/implement/standards/fhir/organization.html


```
{
        "title":"Philips HealthSuite - Personal Health Record",
        "id":"http://fhir.cloud.pcfdev.com/base/Organization/phr",
        "link":[
```

```
                        {
                                "rel":"self",
                                "href":"http://fhir.cloud.pcfdev.com/base/Organization/phr/_history/1"
                        }
                ],
                "updated":"2014-12-16T20:33:03.000+00:00",
                "published":"2014-12-16T20:33:03.000+00:00",
                "content":{
                        "resourceType":"Organization",
                        "text":{
                                "status":"generated",
                                "div":"<div/>"
                        },
                        "name":"Philips HealthSuite - Personal Health Record"
                }
}
```


Patient


```
{
  "resourceType":"Patient",
  "text":{
    "status":"generated",
    "div":"<div><div class=\"hapiHeaderText\"> Lucille <b>Ball Arnez</b></div><table
class=\"hapiPropertyTable\"><tbody><tr><td>Identifier</td><td>MRN</td></tr><tr><td>Address</td><td><span>23
Town Rd </span><br/><span>Shepparton </span><span>Vic </span></td></tr><tr><td>Date of birth</td><td><span>11
April 1945</span></td></tr></tbody></table></div>"
  },
  "identifier":[
    {
      "use":"usual",
      "label":"MRN",
      "system":"urn:oid:1.2.36.146.595.217.0.1",
      "value":"MR000123",
      "period":{
        "start":"2000-01-01"
      },
      "assigner":{
        "display":"Acme Healthcare"
      }
    },
    {
      "use":"official",
      "label":"Philips HealthSuite ID",
      "system":"https://healthsuite-ppe.philips.com/patients",
      "value":"username1",
      "period":{
        "start":"2015-01-01"
      },
      "assigner":{
        "display":"Philips HealthSuite"
      }
    }
  ],
  "name":[
    {
      "use":"official",
      "family":[
        "Ball", “Arnez”
```

```
        ],
        "given":[
          "Lucille"
        ]
      },
      {
        "use":"usual"
      }
    ],
    "telecom":[
      {
        "system":"phone",
        "value":"(213) 799-4456",
        "use":"home"
      },
      {
        "system":"email",
        "value":"lucy@lotasplainin.com",
        "use":"work"
      },
      {
        "system":"phone",
        "value":"(213) 799-3122",
        "use":"mobile"
      }
    ],
    "gender":{
      "coding":[
        {
          "system":"http://hl7.org/fhir/v3/AdministrativeGender",
          "code":"F",
          "display":"Female"
        }
      ]
    },
    "birthDate":"1945-04-11",
    "deceasedBoolean":false,
    "address":[
      {
        "use":"home",
        "line":[
          "23 Town Rd"
        ],
        "city":"Shepparton",
        "state":"Vic",
        "zip":"1230"
      }
    ],
```

The Important Bits

Name

Names are divided into two groups: given and family. The country of origin determines which goes first, for example in the US the given names are displayed before family names. Both “given” and “family” are arrays, and the elements of each array should be displayed in the order they appear. For example, “Dr. Emmett L. Brown Jr” has two given names and one family name, and his record would appear like this:

```
    "name":[
      {
        "use":"official",
        "prefix":[
          "Dr.”
        ],
        "family":[
```

```
          "Brown"
        ],
        "given":[
          "Emmett",
          "L."
        ]
        "suffix":[
          "Jr"
        ],
      },
      {
        "use":"usual"
      }
    ]
```

Prefix and suffix are commonly used optional elements. For the full specification see:
http://www.hl7.org/implement/standards/fhir/datatypes.html#HumanName

Telecom

Telecom elements are a type of Contact element. The important parts here are “system” (phone, fax, or email), “value” (the number or address itself), and “use” (home, mobile, or work). The formal definition of the Contact element can be found here:
http://www.hl7.org/implement/standards/fhir/datatypes.html#contact

Gender

Gender uses the HL7v3 gender coding, but all you usually want is either the code (F, M, UN, UNK) or display element (Female, Male, Undifferentiated, unknown).

Observation

Observations are at the heart of the system. Any activity that produces a measurable result can be expressed as an observation. Observations are indicated with a resourceType of “Observation” and relative URI of “Observation/{observation-id}”

```
{
  "resourceType":"Observation",
  "text":{
    "status":"generated",
    "div":"<div>Weight observation 79.80kg</div>"
  },
  "name":{
    "coding":[
      {
        "system":"https://rtmms.nist.gov",
        "code":"188736",
        "display":"MDC_MASS_BODY_ACTUAL"
      },
      {
        "system":"http://loinc.org",
        "code":"3141-9",
        "display":"Weight"
      }
    ]
  },
  "valueQuantity":{
    "value":79.80,
    "units":"kg",
    "system":"http://unitsofmeasure.org",
    "code":"kg"
  },
```

```
  "appliesDateTime":"2008-01-01T13:18:38-05:00",
  "status":"registered",
  "reliability":"ok",
  "subject":{
    "reference":"Patient/46"
  }
}
```

The Important Bits

Observation Coding

The type of observation is indicated by its coding in the "name" element, which includes a system, code, and display. The system indicates which code system is being used to identify the observation. The code systems themselves can be complex, with generalized codes divided into more specific sub-codes, and many hospitals have dedicated terminology systems to sort all of this out. Fortunately, we have included the codes for common observations for two major code systems which will be used in our test data.

The following tables can be used to populate queries for different observation types.

IEEE-11073 Codes (Code system https://rtms.nist.gov)

ISO/IEEE 11073 is an identifier coding system designed to bridge the gap between health and wellness systems. It includes standard medical measurements such as weight, glucose, and blood pressure, as well as fitness activities, step counters, and sleep monitors.

You can search for more IEEE-11073 codes using the online database at https://rtmms.nist.gov/rtmms/index.htm#!rosetta

Common IEEE-11073 Codes

Name	Code	Display
Weight	188736	MDC_MASS_BODY_ACTUAL
Systolic Blood Pressure	150017	MDC_PRESS_BLD_SYS
Diastolic Blood Pressure	150018	MDC_PRESS_BLD_DIA
Mean Blood Pressure	150019	MDC_PRESS_BLD_MEAN
Blood Pressure (all 3 components together)	150016	MDC_PRESS_BLD
Steps	8454247	MDC_HF_DISTANCE
Glucose	160364	MDC_CONC_GLU_UNDETERMINED_WHOLEBLOOD
Body Temperature	150364	MDC_TEMP_BODY
Heart Rate	8454258	MDC_HF_HR
Respiratory Rate	151562	MDC_RESP_RATE
Mood	67108865	MDC_PHYSIO_MOOD
Pain Level	67108866	MDC_PAIN_LEVEL
Energy Expended	8454263	MDC_ HF_ENERGY
Glycated Hemoglobin	160220	MDC_CONC_HBA1C
Prothrombin Time	160260	MDC_RATIO_INR_COAG

Pulse Rate (taken with blood pressure)	149546	MDC_PULS_RATE_NON_INV
Pulse Rate (taken with oximeter)	149530	MDC_PULS_OXIM_PULS_RATE
Sleep	8455148	MDC_HF_ACT_SLEEP
Sleep Efficiency	67108866	MDC_SLEEP_EFFICIENCY
SPO2 Oxygen	150456	MDC_PULS_OXIM_SAT_O2

Common IEEE-11073 Codes 1

LOINC Codes (Code system http://loinc.org)

LOINC (Logical Observation Identifers Names and Codes) is possibly the most widely used identifier in medical record systems. Most (if not all) hospital data can be queried using these codes. This table is the subset of LOINC codes found in the sample data. LOINC is designed for hospital use and does not include fitness data such as step counters, exercise, and sleep monitoring data. For more LOINC codes, you can search the online database http://search.loinc.org/

Common LOINC Codes

Name	**Code**	**Display**
Weight	3141-9	Body weight measured
Blood Pressure	55284-4	Blood pressure systolic & diastolic
Systolic Blood Pressure	8480-6	Systolic blood pressure
Diastolic Blood Pressure	8462-4	Diastolic blood pressure
Mean Blood Pressure	8478-0	Mean blood pressure
Steps	41950-7	Number of steps in 24 hour Measured
Glucose	2339-0	Glucose [Mass/volume] in Blood
Body Temperature	8310-5	Body temperature
Mood	52497-5	Mood
Glycated Hemoglobin	4548-4	Hemoglobin A1c/Hemoglobin.total in Blood
Prothrombin Time	5902-2	Prothrombin time (PT)
Pulse Rate (blood pressure)	8867-4	Heart rate
Pulse Rate (oximeter)	8889-8	Heart rate by Pulse oximetry
SPO2	59408-5	Oxygen saturation in Arterial blood by Pulse oximetry

Recipes

Your basic FHIR recipe has two parts: the http/https call and the server response. We will concentrate on the GET method, which allows for the searching and retrieval of resources.

In each of these examples, the patient ID is “” and the base URL is:

```
https://<base-url-vhr-fhir>
```

Wherever you see these values, replace them with the appropriate patient ID and server URL if you wish to try them.

For clarity, the query parameters are not URL-encoded here. The parameters must be URL-encoded before submitting to the server. For example, this easy to read unencoded query:

```
https://<base-url-vhr-fhir>/Observation?name=http://loinc.org|8480-6&subject._id=<patient-id>&_format=json&_pretty=true
```

Should be encoded to this before submitting to the server:

```
https://<base-url-vhr-fhir>/Observation?name=http%3A%2F%2Floinc.org%7C8480-6&subject._id=<patient-id>&_format=json&_pretty=true
```

All queries include the parameters _format=json and _pretty=true so the responses come back in nicely formatted JSON.

Log In and Log Out

Get Access Token

A bearer token is required for access to the authentication/authorization methods. To get this, you need your client ID and client secret assigned when you register an application on the developer portal. You must POST to this URL:

```
https://<base-url-vhr-fhir>/v1/oauth2/token?grant_type=client_credientials
```

With an Authorization header consisting of “Basic” followed by a Base 64 encoding of CLIENT_ID:CLIENT_SECRET

If the server recognizes your ID and secret, it will return a response with your access token.

Log In

To log in, POST to this URL:

```
https://<base-url-vhr-fhir>/v1/oauth2/authorize/login
```

Your POST request must contain an Authorization header with the access token in the format “Bearer access_token” and the parameters username and password in the request body.

All subsequent requests must include this Authorization header.

Log Out

To log out, simply send a DELETE request to the logout URL, with authorization=bearer_token in the header.

```
https://<base-url-vhr-fhir>/v1/oauth2/authorize/logout
```

Display the Patient

Getting your patient demographics is a simple call to the patient’s URI

```
https://<base-url-vhr-fhir>/Patient/<patient-id>&_format=json&_pretty=true
```

The patient's URI is the base server URL, plus the path "Patient" to indicate resource type, plus the resource ID.

Get Observations

A search of observations is achieved with a GET call to the Observation URL with one or more search parameters. The parameter subject._id is required, as this indicates the patient identifier. Only observations belonging to that patient will be returned, and since you're not allowed to look at someone else's records, this parameter is required to match the identifier in your user object (see log in).

The "name" parameter indicates the type of observation by using a code and code system. For example, the LOINC code system identifier is http://loinc.org and the LOINC code for body weight measurement is 3141-9, so a search for weight measurements would look like this:

```
https://<base-url-vhr-fhir>/Observation?subject._id=<patient-id>&name=http://loinc.org|3141-9&_format=json&_pretty=true
```

A search for step count using the IEEE-11073 code 8454247 would look like this:

```
https://<base-url-vhr-fhir>/Observation?subject._id=<patient-id>&name=https://rtmms.nist.gov|8454247&_format=json&_pretty=true
```

Get Observations with Date Range

To confine results to within a date range, one or two parameters of "date" with operators "<", "<=", "=>", or ">" may be used.

For example, to get weight observations between noon and 6pm on January 15, 2015:

```
https://<base-url-vhr-fhir>/Observation?name=http://loinc.org|3141-9&subject._id=<patient-id>&date=>2015-01-15T12:00:000-08:00&date=<=2015-01-15T18:00:000-08:00&_format=json&_pretty=true
```

Multiple Observation Type Codes

To get multiple observation types, or to search with multiple code systems, include the system and code in a comma-separated list. For example, blood pressure measurements have three components: systolic, diastolic, or mean. To return all three:

```
https://<base-url-vhr-fhir>/Observation?name=http://loinc.org|55284-4,http://loinc.org|8462-4,http://loinc.org|8480-6&subject._id=<patient-id>&_format=json&_pretty=true
```

Get Observations with Multiple Components

An alternative to searching for blood pressure using all three observation codes, is to search for "Blood pressure" observations and extracting the components. For example, a search for blood pressure:

Will yield a list of results with "related" elements, each of which has a reference target:

```
{
```

```
  "resourceType":"Observation",
  "text":{
    "status":"generated",
    "div":"<div>Blood Pressure: Systolic, Diastolic, and Mean</div>"
  },
  "name":{
    "coding":[
      {
        "system":"http://loinc.org",
        "code":"55284-4",
        "display":"Blood pressure systolic & diastolic"
      },
      {
        "system":"http://snomed.info/sct",
        "code":"75367002",
        "display":"Blood pressure"
      },
      {
        "system":"https://rtmms.nist.gov",
        "code":"150016",
        "display":"MDC_PRESS_BLD"
      }
    ]
  },
  "status":"registered",
  "reliability":"ok",
  "subject":{
    "reference":"Patient/<patient-id>"
  },
  "related":[
    {
      "type":"has-component",
      "target":{
        "reference":"Observation/124190"
      }
    },
    {
      "type":"has-component",
      "target":{
        "reference":"Observation/124191"
      }
    },
    {
      "type":"has-component",
      "target":{
        "reference":"Observation/124192"
      }
    }
  ]
}
```


The three components can be retrieved by referencing the URIs:

```
https://<base-url-vhr-fhir>/Observation/124190
```

```
https://<base-url-vhr-fhir>/Observation/124191
```

```
https://<base-url-vhr-fhir>/Observation/124192
```

Sorting and Paging

Sorting is indicated by the _sort parameter. For example, to get the most recent weight measurements:

```
https://<base-url-vhr-fhir>/Observation?subject._id=<patient-id>&name=http://loinc.org|3141-9,https://rtmms.nist.gov|188736&_sort:desc=date&_format=json&_pretty=true
```

The parameter _sort:desc=date indicates a descending order by date (conversely, _sort:asc=date sorts ascending order by date). Available sort fields for observations include:

- date – the observation date
- value-quantity – the observation value for numeric quantities
- value-string – the observation value for string values

By default, the server will return ten results at a time. This can be modified with the _count parameter. For example to return the 25 most recent observations:

```
https://<base-url-vhr-fhir>/Observation?subject._id=<patient-id>6&_sort:desc=date&_count=25&_format=json&_pretty=true
```

The _count parameter has an upper limit of 50.

To page forward and back, it is necessary to examine the server response to this query. In particular, the resource bundle contains an array called “link” which may have any or all of the following:

- “next” – the URL to retrieve the next set of results (page forward)
- “previous” – the URL to retrieve the previous set of results (page back)

These link URLs contain an internal server reference to the original query (parameter _getpages), with _getpageoffset and _count

The bundle also indicates the total number of results. In this example, the server response indicates a page size of 3, offset of 3 (the 2nd page), and a previous and next link among 1026 results:


```
{
  "resourceType":"Bundle",
  "id":"6674d20b-965f-469a-beee-b69eefd6b251",
  "published":"2015-02-05T14:00:29.311-08:00",
  "link":[
    {
      "rel":"self",
      "href":"http://localhost:8080/hapi-fhir-jpaserver/base?_getpages=9a6232a3-407b-4df7-950d-f99b7c8b77c1&_getpagesoffset=3&_count=3&_format=json&_pretty=true"
    },
    {
      "rel":"previous",
      "href":"http://localhost:8080/hapi-fhir-jpaserver/base?_getpages=9a6232a3-407b-4df7-950d-f99b7c8b77c1&_getpagesoffset=0&_count=3&_format=json&_pretty=true"
    },
    {
      "rel":"next",
      "href":"http://localhost:8080/hapi-fhir-jpaserver/base?_getpages=9a6232a3-407b-4df7-950d-f99b7c8b77c1&_getpagesoffset=6&_count=3&_format=json&_pretty=true"
    },
    {
      "rel":"fhir-base",
      "href":"http://localhost:8080/hapi-fhir-jpaserver/base"
    }
  ],
```

```
    "totalResults":"1026",

...
```