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Introduction to the DTS Implementation of the HL7[®] FHIR[®] Terminology Service

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1 What is DTS?

Apelon's Distributed Terminology Service (DTS) is an open source terminology server (<http://apelondts.org>). DTS provides a platform for creating, managing and deploying controlled vocabularies from simple drop-down lists (e.g., Gender codes or Admission Sources) to complex ontologies (including ICD-10-CM, SNOMED CT, LOINC, RxNorm and more). Validated at all previous Fast Healthcare Interoperability Resources (FHIR) Connect-a-thons, DTS's FHIR terminology services supplement the Java and SOAP layers with an implementation of the resources defined by the FHIR Terminology Services specification (<https://www.hl7.org/fhir/terminology-service.html>), including CodeSystem, ValueSet and ConceptMap. With DTS's FHIR Terminology Services, an application can validate any coded data to ensure data fidelity and compliance with mandated coding systems.

2 What is FHIR?

From https://en.wikipedia.org/wiki/Fast_Healthcare_Interoperability_Resources:

Fast Healthcare Interoperability Resources (FHIR, pronounced "fire") is a draft standard describing data formats and elements (known as "resources") and an Application Programming Interface (API) for exchanging Electronic health records. The standard was created by the [Health Level Seven International](#) (HL7) health-care standards organization.

FHIR builds on previous data format standards from HL7, like HL7 version 2.x and HL7 version 3.x. But it is easier to implement because it uses a modern web-based suite of API technology, including a HTTP-based RESTful protocol, HTML and Cascading Style Sheets for user interface integration, a choice of JSON or XML for data representation, OAuth for authorization and Atom for results.^[1] One of its goals is to facilitate interoperation between legacy health care systems, to make it easy to provide health care information to health care providers and individuals on a wide variety of devices from computers to tablets to cell phones, and to allow third-party application developers to provide medical applications which can be easily integrated into existing systems.

FHIR provides an alternative to document-centric approaches by directly exposing discrete data elements as services. For example, basic elements of healthcare like patients, admissions, diagnostic reports and medications can each be retrieved and manipulated via their own resource URLs. FHIR was supported at an American Medical Informatics Association meeting by companies like Cerner which value its open and extensible nature.

3 What is a FHIR Terminology Service?

From <https://www.hl7.org/fhir/terminology-service.html>:

A FHIR Terminology Service is "a service that lets healthcare applications make use of codes and value sets without having to become experts in the fine details of the value set resource, and the underlying code systems. A server that supports all the functionality described here can be described as a "FHIR Terminology Service", and SHALL conform to [this conformance statement](#)."

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This document and implementation of the DTS FHIR Terminology Service
are written to R4 sequence (version 4.0.1)

The most common uses of a FHIR Terminology Service (FHIR TS) are the following:

- Getting a list of codes for a user picklist
- Finding out whether a code is valid
- Getting a display string for a code
- Translating a code from one system to another
- Determining if one code is subsumed by another

The corresponding FHIR TS operations for these use cases are:

- [\\$expand](#)
- [\\$validate-code](#) ([CodeSystem](#) / [ValueSet](#))
- [\\$lookup](#)
- [\\$translate](#)
- [\\$subsumes](#)

4 The DTS Implementation of a FHIR Terminology Service

DTS provides an extensive Application Program Interface (API) to author, manage and deploy terminologies and value sets. The DTS FHIR TS augments this API allowing implementers to utilize a standards-based interface for easily searching and querying terminologies and value sets. Exchanging of information between disparate systems is therefore possible without the systems (or people) on either end becoming experts in the fine details of the value set resource, and the underlying code system.

To balance the spectrum of use cases ranging from large system implementations with native FHIR services to simpler client applications that want to utilize a FHIR TS without having to speak and parse FHIR messages, the DTS FHIR TS can be accessed via HTTP REST commands as specified by HL7. Apelon provides a number of Java classes that can be used by a client to further simplify how these FHIR interactions are implemented.

The DTS FHIR TS is compliant with FHIR R4 version 4.0.0 released 12/27/18 as the first normative version. These FHIR Terminology Services are currently supported with DTS servers running against the following Application Servers: GlassFish, WildFly, and JBoss (see the [DTS4: Release Notes](#) for more details regarding support for these Application Servers).

5 Getting started with the DTS FHIR Terminology Service

Apelon hosts a demo FHIR Terminology Service running inside a DTS server. The FHIR root URL for this service is <http://fhir.ext.apelon.com/dtsserverws/fhir>. This URL is the root for all URLs used to access all of the FHIR Resources on the server. To see the definition of the ValueSet whose FHIR_Id is “intensional-case-1”, access this url:

<http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/intensional-case-1>.

NOTE: In the case of some Internet Browsers, you may have to “right-click” -> “view page source” to see the returned XML.

A username and password will be required for access. Please contact support@apelon.com for a username and password.

As previously mentioned, the most common uses of a FHIR Terminology Service are the following operations:

- Get a list of codes from a ValueSet
- Find out whether a code is valid
- Get a display string for a code
- Translate a code to another system
- Determine if one code is subsumed by another

The Apelon demo FHIR Terminology Service can be used to implement all of these operations. In all these examples you might be asked for a username and password.

To access the FHIR Terminology Services on your own DTS servers, please use the following base URLs:

JBoss or Wildfly:

`http://[host]:[port]/dtsserverws/fhir` (ex. `localhost:8080/dtsserverws/fhir`)

GlassFish:

`http://[host]:[port]/fhir` (ex. `localhost:8080/fhir`)

The primary resources in a FHIR Terminology Service are CodeSystems, ValueSets, and ConceptMaps. It is important to understand the differences between these objects. From the [HL7 v3 Core Principles](#):

- “A *CodeSystem* defines a set of codes with meanings (also known as enumeration, terminology, classification, and/or ontology) - e.g. define which codes (symbols and/or expressions) exist, and how they are understood.”
- “A *ValueSet* selects a set of codes from those defined by one or more Code Systems to specify which codes can be used in a particular context.”
- FHIR *ConceptMaps* extend these two basic elements by defining a relationship (mapping) from a set of concepts defined in one CodeSystem to one or more concepts defined in another *CodeSystem*. Mappings are one way - from the source to the destination. In many cases, the reverse mappings are valid, but this cannot be assumed to be the case.

Similarly, the primary terminology resources within DTS are Namespaces, Subsets, and Associations.

- A DTS Namespace represents a separate source terminology.
- A DTS Subset is an arbitrary collection of concepts. It may represent concepts that share a specific set of attributes, or simply are commonly used in a well-defined context.
- A DTS Concept Association is a relationship between selected codes within the same or across different Namespaces.

The DTS Implementation of the FHIR Terminology Services represents CodeSystems as DTS Namespaces, ValueSets as DTS Subsets, and ConceptMaps as sets of DTS Concept Associations.

Conversely, DTS represents ValueSets as DTS Subsets, CodeSystems as DTS Namespaces and ConceptMaps as sets of DTS Concept Associations.

Further details on these representations and the following operations can be found in additional documents: **CodeSystem Support**, **ValueSet Support**, and **ConceptMaps and Translations**. These documents are available for download at the Documentation center on ApelonDTS.org in the **DTS 4 FHIR Terminology Service Guides** package.

5.1 Get a List of Codes from a ValueSet

A FHIR ValueSet is a list of concepts from one of more CodeSystems. The ValueSet can be defined as an explicit set of codes, for example, LOINC codes “55284-4” and “50402-7”, or as a computable expression, for example, “all of the concepts that are SNOMED-CT observations”. The resolved list of the ValueSet’s concepts is called an **expansion** (\$expand operation) of the ValueSet. To get a ValueSet from the DTS FHIR demo server send the following request from a web browser:

[http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/intensional-case-1/\\$expand](http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/intensional-case-1/$expand)

This request will return all the concepts in the intensional-case-1 value set represented as a FHIR ValueSet resource in XML. The response will include something similar to the following: (NOTE: View Page Source may also be required for this returned XML)

```
<contains>
  <system value="http://loinc.org"/>
  <version value="2.44.13AA"/>
  <code value="55284-4"/>
  <display value="Blood pressure systolic and diastolic"/>
</contains>
<contains>
  <system value="http://loinc.org"/>
  <version value="2.44.13AA"/>
  <code value="50402-7"/>
  <display value="Blood pressure systolic and diastolic--after transfusion"/>
</contains>
```

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5.2 Find out whether a Code is a Valid Member of a CodeSystem or ValueSet

Validation of a code in a CodeSystem or ValueSet can be done using the FHIR \$validate-code operation. For instance, sending the following request from a web browser will validate the LOINC code 55284-4 in the intensional-case-1 ValueSet.

[http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/intensional-case-1/\\$validate-code?code=55284-4&system=http://loinc.org](http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/intensional-case-1/$validate-code?code=55284-4&system=http://loinc.org)

The response from this request indicates that the “55284-4” code in the LOINC namespace is included in the intensional-case-1 ValueSet in the response shown below.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<Parameters xmlns="http://hl7.org/fhir" >
  <parameter>
    <name value="result"/>
    <valueBoolean value="true" id="7dca5f0c-ea56-49c2-b883-af6e62d62364"/>
  </parameter>
  <parameter>
    <name value="display"/>
    <valueString value="Blood pressure systolic and diastolic"/>
  </parameter>
</Parameters>
```

5.3 Get a Display String for a Code in a CodeSystem

Getting a display string for a given code in a CodeSystem can be done using a FHIR \$lookup operation. Sending the following request from a web browser will return the appropriate display string for that code.

[http://fhir.ext.apelon.com/dtsserverws/fhir/CodeSystem/\\$lookup?code=55284-4&system=http://loinc.org](http://fhir.ext.apelon.com/dtsserverws/fhir/CodeSystem/$lookup?code=55284-4&system=http://loinc.org)

The response for this request will be similar to the following.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<Parameters xmlns="http://hl7.org/fhir" >
  <parameter>
    <name value="name"/>
    <valueString value="LOINC"/>
  </parameter>
  <parameter>
    <name value="display"/>
    <valueString value="Blood pressure systolic and diastolic"/>
  </parameter>
</Parameters>
```

5.4 Translate a Code from one CodeSystem to another with a ConceptMap

A FHIR \$translate request can be used to get a code in a *target* CodeSystem that is mapped from a code in a *source* CodeSystem. Sending the request shown below will return a FHIR response that includes the ICD-9 concept mapped to a SNOMED-CT code of 247913006 in the SNOMED CT to ICD9-CM concept map.

[http://fhir.ext.apelon.com/dtsserverws/fhir/ConceptMap/SNOMED%20CT%20to%20ICD-9-CM/\\$translate?system=http://snomed.info/sct&source=http://snomed.info/sct&code=247913006&target=http://hl7.org/fhir/sid/icd-9-cm](http://fhir.ext.apelon.com/dtsserverws/fhir/ConceptMap/SNOMED%20CT%20to%20ICD-9-CM/$translate?system=http://snomed.info/sct&source=http://snomed.info/sct&code=247913006&target=http://hl7.org/fhir/sid/icd-9-cm)

The response from this request will look similar to the following:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<Parameters xmlns="http://hl7.org/fhir" xmlns:ns2="http://www.w3.org/1999/xhtml">
  <parameter>
    <name value="result"/>
    <valueBoolean value="true" id="945d6390-40f6-42a4-82cf-d3ce1a5e1fa3"/>
  </parameter>
  <parameter>
    <name value="outcome"/>
    <valueCoding>
      <system value="http://hl7.org/fhir/sid/icd-9-cm"/>
      <code value="781.0"/>
    </valueCoding>
  </parameter>
</Parameters>
```

5.5 Determine if a Code in a CodeSystem is Subsumed by Another

The FHIR \$subsumes operations allows a user to determine if one code in a CodeSystem is subsumed by another. There are four possible outcomes for a \$subsumes request: equivalent, subsumes, subsumed-by, and not-subsumed. The request shown below will return a FHIR response that provides subsumption information about SNOMED CT codes 3738000 and 235856003.

[http://fhir.ext.apelon.com/dtsserverws/fhir/CodeSystem/\\$subsumes?system=http://snomed.info/sct&codeA=3738000&codeB=235856003](http://fhir.ext.apelon.com/dtsserverws/fhir/CodeSystem/$subsumes?system=http://snomed.info/sct&codeA=3738000&codeB=235856003)

The response from this request looks similar to the response below and indicates that code “3738000” is subsumed by code “235856003”.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<Parameters xmlns="http://hl7.org/fhir" xmlns:ns2="http://www.w3.org/1999/xhtml">
  <parameter>
    <name value="outcome"/>
    <valueCode value="subsumed-by"/>
  </parameter>
</Parameters>
```


5.6 Commonly Used Operations with URL examples

Below we have added two examples of the most common operations we see used in FHIR, with a sample of the corresponding URL. Note that the portion of the URL for the base server name: (fhir.ext.apelon.com) will be replaced by the server name where your FHIR services are hosted.

5.6.1 Get a ValueSet

To return an xml result of the logical definition of a ValueSet, we will locate it by the FHIR_Id property of the ValueSet .

For example:

<http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/2.16.840.1.113883.3.526.2.591>

Here we see the server name (<http://fhir.ext.apelon.com>), the DTS FHIR service call ([/dtsserverws/fhir](#)), the operator to call a Value Set ([/ValueSet](#)), and then the value of the FHIR_Id for this particular Value Set ([/2.16.840.1.113883.3.526.2.591](#)).

The resulting xml returned shows us the definition of the Value Set including the expression.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<ValueSet xmlns="http://hl7.org/fhir" xmlns:ns2="http://www.w3.org/1999/xhtml">
  <id value="2.16.840.1.113883.3.526.2.591"/>
  <meta>
    <lastUpdated value="2016-09-14T18:22:51.854-04:00"/>
  </meta>
  <url
value="http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/2.16.840.1.113883.3.526.2.591"/>
    <identifier id="url">
      <value
value="http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/2.16.840.1.113883.3.526.2.591"/>
    </identifier>
    <name value="End Stage Renal Disease (ICD9CM) eCQM"/>
    <status value="draft"/>
    <compose>
      <include>
        <system value="http://hl7.org/fhir/sid/icd-9-cm"/>
        <version value="2014.1.13AA"/>
        <concept>
          <code value="585.6"/>
        </concept>
      </include>
    </compose>
  </ValueSet>
```

5.6.2 Get Expanded ValueSet Concept List

If we use the same URL from above, but append the operator **/Expand** afterward, we'll not only get the Value Set definition as we see above, but an additional expansion block in the xml, containing all the concepts within the Value Set.

Example:

[http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/2.16.840.1.113883.3.526.2.591/\\$expand](http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/2.16.840.1.113883.3.526.2.591/$expand)

Note below, the initial metadata defining the Value Set appears the same as the previous operation, but the /\$expand has granted us an additional “<expansion>” xml tag, bolded below for clarity.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<ValueSet xmlns="http://hl7.org/fhir" xmlns:ns2="http://www.w3.org/1999/xhtml">
  <id value="2.16.840.1.113883.3.526.2.591"/>
  <meta>
    <lastUpdated value="2016-09-14T18:22:51.854-04:00"/>
  </meta>
  <url
value="http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/2.16.840.1.113883.3.526.2.591"/>
    <identifier id="url">
      <value
value="http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/2.16.840.1.113883.3.526.2.591"/>
    </identifier>
    <name value="End Stage Renal Disease (ICD9CM) eCQM"/>
    <status value="draft"/>
    <compose>
      <include>
        <system value="http://hl7.org/fhir/sid/icd-9-cm"/>
        <version value="2014.1.13AA"/>
        <concept>
          <code value="585.6"/>
        </concept>
      </include>
    </compose>
    <expansion>
      <identifier
value="http://fhir.ext.apelon.com/dtsserverws/fhir/ValueSet/2.16.840.1.113883.3.526.2.591"/>
        <timestamp value="2018-11-12T12:05:50.052-05:00"/>
        <total value="1"/>
        <offset value="0"/>
        <contains>
          <system value="http://hl7.org/fhir/sid/icd-9-cm"/>
          <version value="2014.1.13AA"/>
          <code value="585.6"/>
          <display value="End stage renal disease"/>
        </contains>
      </expansion>
    </ValueSet>
```

5.7 Additional Functionality

The functionality described here is only some of the full FHIR Terminology Service specification and the functionality implemented by the DTS implementation of the FHIR Terminology Service specification. Additional information on the full FHIR Terminology Service specification is available at <https://www.hl7.org/fhir/>. Apelon has also recently included support for several common CodeSystems (detailed in the **CodeSystem Support** guide), ValueSet (detailed in the **ValueSet Support** guide) as well as support for a handful of search parameters, modifiers and prefixes (see the **Searching in DTS FHIR**

document). These additional documents are available for download at the Documentation center on ApelonDTS.org in the **DTS 4 FHIR Terminology Service Guides** package.

6 More Information

More information on the DTS implementation of the FHIR Terminology Service can be obtained by contacting us at support@apelon.com.