A Terminology Service Compliant to CTS2 to Manage Semantics within the Regional HIE

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Abstract

Objectives: The correct semantics management represents a fundamental requirement to create health information exchange (HIE) systems able to support clinical data sharing. A research is now underway to set up an infrastructure to aggregate data coming from health information systems, and it will be experimented to support regional HIE in Veneto region, Italy.

Methods: In the first period, the focus was on the semantics management of Clinical Document Architecture Release 2 (CDA R2) laboratory reports, in which observations must be encoded using LOINC® vocabulary. The existing components considered were the Laboratory Information Systems (LISs) of the local departments of the region (23 units) and the regional HIE. To manage the semantics of the data, the design and the implementation of a terminology service, the Health Terminology Service (HTS), compliant to the Common Terminology Service Release 2 (CTS2) standard was considered.

Results: The HTS, formed by a set of web services, as CTS2 indicates, is the core of the proposed infrastructure. It is connected with an application that allows creating, deleting, updating and managing the versioning of the maps between the laboratory observations and the LOINC® entities.

Conclusions: The adoption of CTS2 specification allows the HTS to support different use cases, which are essential to supports the clinical data sharing of the HIE content. During the development, the authors faced some problems that cause a delay in the implementation of the solution. The authors are still working to connect the HTS with the existing systems and to improve the solution.

Keywords

Semantics management; Laboratory Information System (LIS); Health Information Exchange (HIE); Common Terminology Service Release 2 (CTS2); Laboratory reports

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1 Introduction

The clinical data sharing represents a fundamental process to improve the medical research, patient care and reduce health costs [1, 2]. The Health Ministries of many developed countries are planning the creation of national health information exchange (HIE) systems by defining the functionalities to support the sharing of its content [3, 4].

In order to realize distributed system architectures able to satisfy this requirement, the management of semantics is a critical and essential aspect that must be considered. In this context, standardized terminologies, universally recognized for the specific application domain, must be adopted to semantically enrich data that are shared [4].

The use of these well-defined tools is not enough to solve the problem. In clinical practice, each medical department uses its internal terminology that is usually very different from standardized vocabulary [5]. Therefore, it is important to represent the concepts and the relations between these concepts, defined in different local and standardized terminologies, so that can be understood and processed my machine, passing from the description of data to description of knowledge.

In addition, the medical knowledge evolution causes the change of concepts and terms, used to define them. For example the standardized vocabulary LOINC® (Logical Observation Identifiers Names and Codes) [6] is updated about twice every year. For this reason, it is necessary to maintain terminologies and their relations updated and coherent over the time, that is manage historical evolution and versioning [7].

From 2011, some of the authors were involved in two similar but separated initiatives to create prototypal solutions to manage semantics of laboratory tests, in particular the mapping between concepts at regional level. In both cases, concepts of local terminologies were encoded in the corresponding LOINC® codes through a translation process. The first initiative was performed in Veneto region within the regional project Veneto Escape [8]. In this case the translation project was performed by laboratory technicians through an ad hoc web application for a limited number of lab tests. At the end on the mapping, the resulting harmonization was stored within a database and it could be downloaded through a table that contains a view of all laboratory tests and the selected LOINC® entities. These *table* were uploaded in LISs in order to use LOINC® codes in the CDA R2 laboratory reports.

The second initiative was carried in Liguria region and the harmonization process was performed on Excel files by the authors with the cooperation of laboratory technicians through several cycles of translation proposals, review and approval on small set of codes. In this case, the resulting harmonization was stored within a database and was available through specific stored procedures in order to read the maps between codes [5]. After this experience, some of the authors decided to improve this prototype in order to design and develop a solution able to support both more terminologies and more functionalities as query and maintenance operations, adopting standardized solutions.

Taking in account these two experience, since 2015 a research is now to set up an infrastructure able to manage semantics at regional level that will be experimented to support regional HIE in Veneto Region. The aim of this infrastructure is to aggregate data coming from a regional HIE basing on semantic meaning of all available data [9]. In this paper, the authors present the first steps of this research, the current state of implementationa, the issues faced and the next steps.

2 Methods

In order to develop the overall solution that this ambitious research aimed to, different macro phases were considered. In particular, the first period of 2 years was designed to focus on the management of semantics in laboratory reports. For this reasons, the existing considered components were the Laboratory Information Systems (LISs) of the local departments of the Veneto region (23 units) and the regional HIE.

As indicated by the Italian Health Ministry, laboratory reports must be structured adopting the HL7 Clinical Document Architecture Release 2 (CDA R2) standard following the HL7 Italy Implementation Guide for Laboratory Reports [10] and the IHE (Integrating the Healthcare Enterprise) Laboratory Technical Framework [11]. According to this guide, the LOINC® vocabulary must be adopted to translate laboratory observations. For this reason, the authors decided to use LOINC® as reference code system. Another code system considered was the regional catalog of prescriptions.

To manage the semantics of the data involved in the contextual workflow, the design and the implementation of a terminology service was considered. In particular, in order to satisfy all requirements indicated by the project, the Common Terminology Service Release 2 (CTS2) standard was adopted [7, 12]. CTS2 is one of the products of the HL7 and Object Management Group (OMG) initiative called Healthcare Service Specification Project (HSSP) [13]. The aim of HSSP was to define health industry standards based on Service Oriented Architecture (SOA) approach to provide and guarantee an effective interoperability between distributed and heterogeneous applications which belong to independent socio-health system organizations [4, 13, 14, 15, 16].

The CTS2 standard provides a consistent specification to develop service interfaces to manage, search and access terminology content independent of the terminology content and underlying technological stack. For this reason, a terminological service compliant to CTS2 contributes to interoperability by supporting an easy access to the foundational elements of shared semantics. CTS2 defined different elements called *terminology resources* and different set of operations, called *functional profiles*, which could be performed on them. These functionalities can be implemented adopting several approaches [7, 12].

As all HSSP standards, CTS2 is distributed through the HL7 Service Functional Model (SFM), which provides a service interface specification at a functional level, and the OMG Service Technical Model (STM), which specifies the technical requirements of the service [4, 7, 16]. In details, each OMG STM is formed by a set of human readable specification documents (e.g. pdf) and some computer processable files (e.g. WSDL and XSD) that can be used to automatically generate the interfaces adopted by web services and client applications to interact. The HL7 SFM for CTS2 is available at [7] while the OMG STM is available at [12].

The idea of the authors was to design and develop a complete terminology service considering the overall CTS2 specification. The authors decided to start to focus on the CTS2 *terminology resources* that were needed to satisfy the requirements of the first phase of the research:

- CodeSystem: either a classification system or a code system or a ontology or a thesaurus, etc. that may also carry information about its publisher, release cycles, purpose, etc
- CodeSystemVersion: a version of a CodeSystem that may also carry information about the release date, release format, contact information, etc.
- EntityDescription: a description about either a class or a role or a individual along with links to the CodeSystemVersion in which this description originates.
- Map: a collection of rules for transforming information represented using one CodeSystem into information represented in second one that may also carry information about the creators, intended use, CodeSystem involved, etc.
- MapVersion: a version of a Map that carries the *from* and the *to* CodeSystemVersion as well as a representation of the rules and process for the conversion.
- MapEntry: a definition of a set of rules that identifies how a single Entity that belongs to the *from* CodeSystemVersion maps to zero or more target Entities that belong to the *to* CodeSystemVersion.

For all these elements, the following *functional profiles* were considered:

- Maintenance: set of capabilities to *create*, *update*, *delete* a *terminology resource* through sets of changes, called *ChangeSets*, with specific properties to indicate the creation date, the user that changes the terminology content, the change information, the effective date, etc.
- Read: set of capability to *read* a *terminology resource* in a specific context (e.g. language, time, changeset).
- Query: set of capability to *search* the *terminology resources* with specific features in a certain context (e.g. language, time, changeset).
- History: set of capabilities to get the list of all the changes applied to a particular *terminology resource* and the list of all the *ChangeSet* applied to the whole terminology content.

The SOAP (Simple Object Access Protocol) was chosen as *implementation profile* and Microsoft Windows Azure was adopted as cloud platform to host the terminology service. The reason of this choice was that it provided high availability, scalability and manageability, fault tolerance, geo-replication, limitless storage, and security on the cloud. It allows the adoption of load balancing to implement failover, i.e., the continuation of a service after the failure of one or more of its components. Load balancing also enables other important features such as scalability [16 ,17, 18].

3 Results

In order to set up an infrastructure able to manage semantics of the content of laboratory reports, the authors designed the architecture represented in Figure 1. The solution is formed by the following independent and distributed systems:

- the regional HIE,
- the 23 LISs of the local departments of the Veneto region,
- the terminology service, called Health Terminology Service (HTS),
- the client web application to manage the content of the HTS (presented in the right side of Figure 1).

3.1 HTS

The core of the architecture is the HTS that is assembled by a *terminology database*, which stores all the information related to the terminology resources, and a set of web services (indicated in Figure 1 as *CTS2 Interface*), which provides access to the terminology database through interfaces compliant to the CTS2 standard. The *terminology database*, which was designed and implemented starting from the CTS2 OMG STM information model, is a very complex relational database, hosted on Microsoft SQL Azure. The *CTS2 Interface*, which was developed starting from the computer processable files provided within the CTS2 OMG STM, is represented by a set of Windows Communication Foundation (WCF) services, hosted on Microsoft Azure. In details, as indicated by the CTS2 standard, each terminology resource has a specific service for each supported functional profile. As mentioned in Methods section, the terminology resources considered were six and the authors implemented the maintenance, the read, the query and the history functional profiles, therefore the HTS is formed by 24 WCF services that are:

- CodeSystemCatalogReadService
- CodeSystemCatalogQueryService

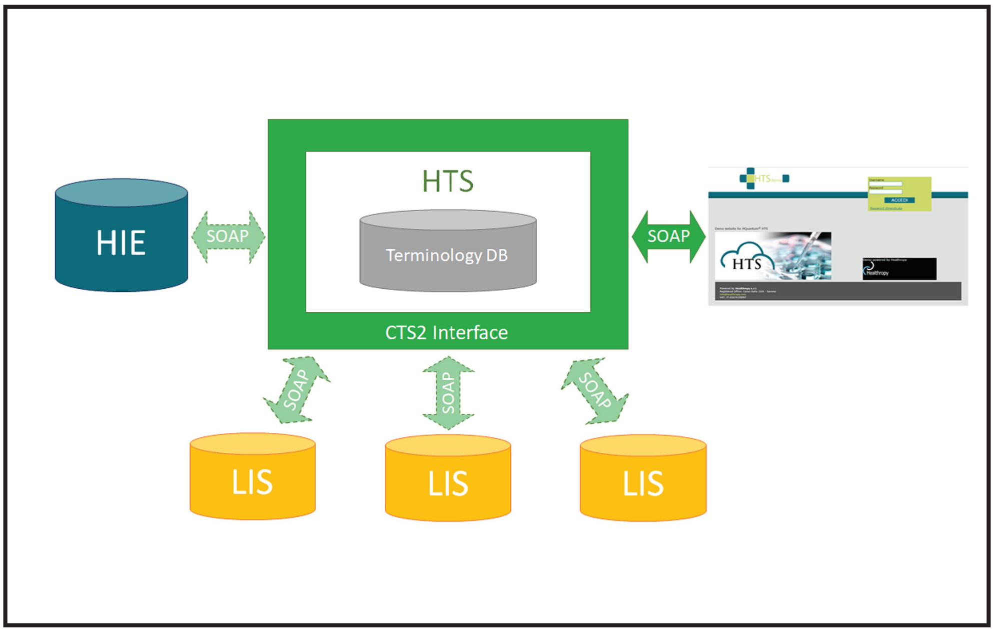

Figure 1: Proposed architecture to support semantics management at regional level.

- CodeSystemCatalogMaintenaceService
- CodeSystemCatalogHistoryService
- CodeSystemVersionCatalogReadService
- CodeSystemVersionCatalogQueryService
- CodeSystemVersionCatalogMaintenaceService
- CodeSystemVersionCatalogHistoryService
- EntityDescriptionReadService
- EntityDescriptionQueryService
- EntityDescriptionMaintenaceService
- EntityDescriptionHistoryService
- MapCatalogReadService
- MapCatalogQueryService
- MapCatalogMaintenaceService
- MapCatalogHistoryService
- MapVersionReadService
- MapVersionQueryService
- MapVersionMaintenaceService
- MapVersionHistoryService
- MapEntryReadService
- MapEntryQueryService
- MapEntryMaintenaceService
- MapEntryHistoryService

3.2 Client Web Application

In order to allow human users to manage the content of the HTS terminology database, a web application, which is client of the HTS WCF services, was involved. This application was designed and developed by the authors in deep collaboration with the medical staff that was responsible for the harmonization process between local terminologies and LOINC® vocabulary. It is continuously evolving to satisfy both the needs of laboratory technicians and the requirements that the Veneto region is designing to create the regional HIE and to manage the semantics of its content. For this first phase, the authors defined three user categories:

- *Terminology Administrators*: users that can manage all terminology resources;
- *Regional Terminology Administrators*: users that can manage only some terminology resources at regional level, so for all local departments of the Veneto region;
- *Local Terminology Administrators*: users that can manage only some terminology resources at local level, so for one or more specific local departments.

At the present, the web application is formed by three sections: user management, LIS management and mapping management.

User Management

In this section of the web application, all users can modify their credentials and *Terminology Administrators* and *Regional Terminology Administrators* can create new users. They can decide if the new user would be a *Regional Terminology Administrators* or a *Local Terminology Administrators* and in this case, they can select one or more local departments that the user would administrate.

LIS Management

The second section is used by the users to insert within the HTS the list of all laboratory observations, performed by each local department, indicating all their properties as code, description, units, specimen and the corresponding code defined within the regional catalog of prescriptions. The input can be manual, by completing a form, or can be automatic, by uploading a spreadsheet with preset structure. *Terminology Administrators* and *Regional Terminology Administrators* can insert laboratory observations for all local departments, while *Local Terminology Administrators* can do it only for the departments for which they are administrators. If the user is administrator of more than one department, the application asks to select the department that must be considered.

Mapping Management

This last section is the core of the application, which allows creating, deleting, updating and managing the versioning of the maps between the laboratory observations and the LOINC® entities. It is formed by a set of web pages that allow users to perform different sets of operations to guide the process of terminology management:

1. Map priority setting
2. Map creation
3. Elimination or update of the created maps
4. View of the created maps and of the state of map progress
5. Management of new LOINC® versions release and automatic versioning of maps
6. Manual versioning of maps where needed

The first form allows setting the map priority. As previously mentioned, with the LIS management section all laboratory observations are stored in the HTS with the corresponding code defined within the regional catalog of prescriptions. *Terminology Administrators* and *Regional Terminology Administrators* can select the codes of this catalog whose corresponding laboratory observations of local departments must be mapped with major priority.

The second set of web pages allows *Local Terminology Administrators* to create the association between local laboratory observations and LOINC® entities for the departments for which they are administrators. In order to help *Local Terminology Administrators*, a laboratory technician that has a thorough knowledge of LOINC, the *Alpha User*, was elected. His aim was to choose, for each code of the regional catalog of prescriptions, a set of possible LOINC® entities that could correspond to the prescription.

Also for this set of web forms, if the user is administrator of more than one department, she/he had to select the department that wants to consider. The system presents for the specific department all the laboratory observations that are unmapped, sorted by map priority in descending order. In addition, it highlights the observation with major priority. By this way, the user knows what observations must be managed first. After that the user has selected the observation that she/he wants to map, she/he can decide to adopt one of the following three approaches:

1. To view the set of LOINC® entities, selected by the *Alpha User*, related to the same code of the regional catalog of prescriptions of the chosen observation;
2. To view the LOINC® entities adopted in the other departments to map observations related to the same code of the regional catalog of prescriptions of the chosen observation;
3. To directly search in LOINC® website.

In all cases, after that the user has selected a LOINC® entity, the system presents all laboratory observations that was mapped with this LOINC® entity by the other departments. If the user confirms the operation, the map is created in HTS.

With the third form, *Local Terminology Administrators* can view all the maps that they created and can update or delete the associations between the laboratory observations and LOINC® entities. In case they delete a map, the corresponding laboratory observation becomes unmapped and, therefore, visible through the second sets of web pages.

Terminology Administrators and *Regional Terminology Administrators* through the fourth form can have a view of state of map progress and can see all the maps. In details, they can see in a schematic table for each department the number of all the laboratory observations and the number of the mapped ones. In addition, they can see all the maps with the corresponding department and download then via excel files. Table 1 shows examples of maps created by *Local Terminology Administrators* for different laboratories, between laboratory observations and LOINC® entity corresponding to the same entity of the regional catalog of prescriptions (code: 90.43.2_0, description: triglycerides).

When LOINC® releases a new version, *Terminology Administrators* and *Regional Terminology Administrators* can use the fifth set of web forms to manage the versioning of maps of all departments. As first step, the system presents a schematic comparison between the actual and the previous LOINC® versions. It indicates:

- the number of all LOINC® entities not deprecated in the actual and in the previous version
- the number of new LOINC® entities present in the actual version respect to the previous one
- the number of eliminated LOINC® entities in the actual version respect to the previous one

Table 1: Maps between internal laboratory observation (Internal Presctiprion Code, Internal Prescription Description, Internal Observation Code, Internal Observation Description, Units, Specimen) and Loinc code of different laboratory (Lab) corresponding to the prescription „Triglicerides“ of the regional catalog of prescriptions.

Lab	Internal Prescription Code	Internal Prescription Description	Internal Observation Code	Internal Observation Description	Units	Specimen	LOINC® Code
1	a253	Triglycerides	a253	Triglycerides	mg/dL	PLASMA	2571-8
2	TGL	TRIGLYCERIDES	TGL	S-TRIGLYCERIDES	mg/dL	Serum	2571-8
3	132	Triglycerides	132	Triglycerides		P-PLASMA	2571-8
4	5	P-TRIGLYCERIDES	5	P-TRIGLYCERIDES	mg/dL	Ser/Plas	2571-8
5	TGL	P-Triglycerides	TGL	P-Triglycerides	mmol/L		14927-8
6	trig	s-TRIGLYCERIDES	trig	s-TRIGLYCERIDES	mg/dL	serum	2571-8
7	1035	S-TRIGLYCERIDES	1	S-TRIGLYCERIDES	mmol/L	Plasma	14927-8
7	1035	S-TRIGLYCERIDES	2	S-TRIGLYCERIDES second unit	mg/dL	Plasma	2571-8
8	LX148	S-TRIGLYCERIDES	148	P-TRIGLYCERIDES	mg/dL		2571-8
9	214C	TRIGLYCERIDES	214	P-TRIGLYCERIDES	mg/dL	PLASMA	2571-8
10	025	TRIGLYCERIDES	025	TRIGLYCERIDES	mg/dL		2571-8
11	210	S-TRIGLYCERIDES	210	S-TRIGLYCERIDES	mg/dL		2571-8
12	K02	TRIGLYCERIDES	K02	S-TRIGLYCERIDES	mM/L	SERUM	14927-8
12	K02	TRIGLYCERIDES	K02	S-TRIGLYCERIDES	mg/dL	SERUM	2571-8
13	TRIG	Triglycerides	TRIG	Triglycerides	mg/dL	S - Blood	2571-8
14	1035	S_TRIGLYCERIDES	1035-1	S_TRIGLYCERIDES-1	mmol/L	Serum	14927-8
14	1035	S_TRIGLYCERIDES	1035-2	S_TRIGLYCERIDES-2	mg/dL	Serum	2571-8
15	253	P-Triglycerides	253	P-Triglycerides	mg/dL	PLASMA	2571-8
16	TRIG	P-TRIGLYCERIDES	TRIG	P-TRIGLYCERIDES	mg/dL		2571-8
16	TRIG	P-TRIGLYCERIDES	TRIG	P-TRIGLYCERIDES (2° UM)	mmol/L		14927-8
17	210	TRIGLYCERIDES	210	TRIGLYCERIDES	mg/dL	PLASMA PL	2571-8
17	210	TRIGLYCERIDES	210	TRIGLYCERIDES	mmol/L	PLASMA PL	14927-8
18	CH59	TRIGLYCERIDES	CH5701	Triglycerides	mg/dL	Heparin Plasma	2571-8
19	0055	TRIGLYCERIDES	0055	TRIGLYCERIDES	mg/dL	serum	2571-8
20	0379	P-TRIGLYCERIDES	T35	Triglycerides	mmol/L		14927-8
20	0379	P-TRIGLYCERIDES	T35	Triglycerides (2° UM)	mg/dL		2571-8
20	0379	P-TRIGLYCERIDES	T46	Cholesterol LDL	mmol/L		39469-2
20	0379	P-TRIGLYCERIDES	T46	Cholesterol LDL (2° UM)	mg/dL		13457-7
21	T35	P-Triglycerides	T35	Triglycerides	mmol/L		14927-8
21	T35	P-Triglycerides	T35	Triglycerides (2° UM)	mg/dL		2571-8
22	TG	Triglycerides	TG	P-TRIGLYCERIDES	mg/dL	PLASMA	2571-8

- the number of maps between entities in the previous version and entities in the last one (provided by LOINC®).

Then the application shows a table that presents, for each LOINC® property, the number of LOINC® entities that have changed the value of the specific property. This allows *Terminology Administrators* and *Regional Terminology Administrators* to have a vision of the overall changes in LOINC vocabulary. The user can select the LOINC® property that must be considered by the system to manage the automatic versioning of maps. After this phase, the system allows *Terminology Administrators* to run the following algorithm:

a) For each local department, the system considers the maps from laboratory observations of the specific LIS to the LOINC® entities in the precedent version.

b) For each map, it gets the used laboratory observation and LOINC® entity (defined within the precedent version).

c) If the LOINC® entity exists in the actual version too, the application considers this entity (go to step e).

d) If the LOINC® entity does not exist in the actual version, it uses the map from the LOINC® previous version to LOINC® last version and gets the corresponding LOINC® entity in the actual version.

e) The system compares the values of the property previously selected by the user of the two LOINC® entities.

f) If all values are equal, the system creates a new map from the laboratory observation (get in step b) and the LOINC® entity.

g) If there is at least one value different, the system saves the map as to be manually validated by *Local Terminology Administrators*. Then it passes to the next map (go to step b).

h) When all maps of a department have been processed, the application sends an e-mail to *Local Terminology Administrators* of the specific department, to *Terminology Administrators* and to *Regional Terminology Administrators*. Then it passes to the next local department (go to step b).

The last set of web forms allows *Local Terminology Administrators* to manually manage the maps that must be validated. The system presents a list of all these maps and, after that the user has selected a specific map, it shows the two LOINC® entities, one in the previous version and one in the last version, with all their properties and highlights the values that are different. Then the user can decide if the map between the laboratory observation and LOINC® entity can be confirmed or not. In the first case, the system creates a new map, while in the second one, the laboratory observation becomes unmapped and, therefore, visible through the second sets of web pages.

3.3 Numeric Results

At the present, the HTS manages 25 CodeSystems, 27 CodeSystemVersions, about 260000 EntityDescriptions, 47 MapCatalogs, 71 MapVersions and about 30000 MapEntries. After the last release of LOINC, the automatic versioning of maps allowed automatically creating more than 11500 MapEntries that means that the system automatically validated about 80% of the existing maps in the previous LOINC® version. About 800 LOINC entities adopted in the maps changed from the previous to the last version and the *Local Terminology Administrators* had to manually validate about 3000 maps.

Discussion and Conclusions

The adoption of CTS2 specification allows the HTS to support different use cases, which are essential to manage semantics to support the clinical data sharing of the HIE content. A example of use case could be the one reported in the Figure 2: the automatic update of the HIE content with a new laboratory report. When a physician prepares a laboratory report, the client application of LIS, for each local code, used in the report, communicates with the HTS by calling several CTS2 functionalities (represented in a single interaction, Translation (local code), in Figure 2 for simplicity) to get the corresponding LOINC® code. Then, the LIS client application can use these LOINC® codes to create the CDA R2 document that can be digitally signed and sent to the regional HIE following the national specifications. Another example can be the comparison of laboratory observations contained within reports produced in different years so adopting different LOINC® versions. Thanks to history functional profile, it is possible to get all changes performed on the HTS content and retrieve the corresponding LOINC® entities in the different versions. A similar example can be the management of laboratory reports stored in the HIE adopting outdated LOINC entities. The authors are planning an algorithm that will allow interacting with the HTS and retrieving the corresponding LOINC® entity in the actual version. This could be possible using the versioning of two maps stored in HTS; the first one is between laboratory observations and LOINC® entities and the other one is between entities in different LOINC® versions, provided by LOINC®. If the specific laboratory observation was mapped with an entity in the current LOINC® version, the system will return this LOINC® entity as the corresponding entity, while if the laboratory observation was not mapped in any entity in the current LOINC® version, the system will process the maps provided by LOINC® in the different versions to return the corresponding LOINC® entity in the current version.

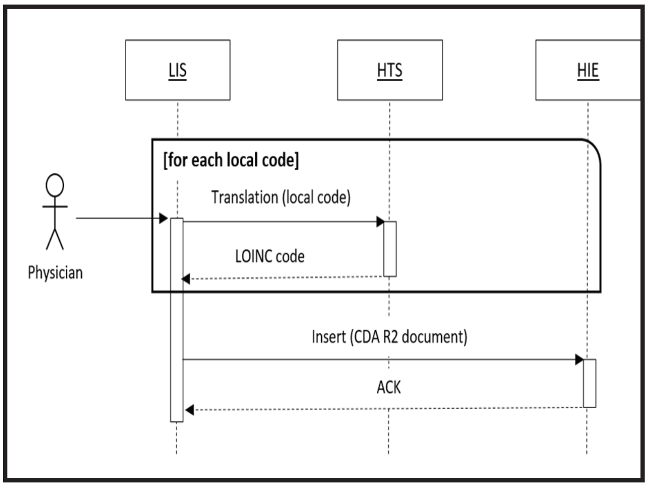

Figure 2: Example of use case supported by the architecture to manage semantics.

Another important advantage of CTS2 is that it proposes an information model where all the terminology resources are well defined and separated allowing the complete control of the terminology content. In fact, the CTS2 information model allows defining different access profiles to the terminology content. For example, it is possible to establish for each user a set of pairs of terminology resource and functional profile for which she/he is allowed to have access. The advanced management of these access profiles is research argument of some of the authors.

During the development of HTS, the authors had to face some problems related to errors in the computer processable files provided by OMG. Three classes of errors were found: not compliance with the information model described in the human readable specification documents, syntax errors and structural errors. The authors had to correct all the errors in the processable files before generate all the needed services interfaces. The authors are preparing a white paper with all the errors that they found in order to share this knowledge with HL7 and OMG members.

The correction of errors in processable files caused a delay in the implementation of the HTS and in the first release of the client web application. For this reason, at the present this application is connected only to some services of HTS. In fact, the authors had to decide what functionalities of the web application must develop with priority basing on the deadlines that the Veneto region designed to create the regional HIE and to manage the semantics of its content. Therefore, the authors had to upload some terminology resources as all entities of the regional catalog of prescriptions and LOINC® directly in the database through stored procedures. The authors are working on the second release of the client web application that will allow managing all the terminology content only calling the CTS2 HTS interfaces.

In the next phases of the research project, the HTS will be also directly connected with the LIS of 4 local departments in order to realize the use case represented in Figure 2. At the present, the maps between the local laboratory observations and LOINC® entities are first downloaded through the fourth form via excel files and then directly uploaded in the application of the LISs that creates the CDA R2 containing the laboratory report.

Finally, in the next months the authors want to improve the comparison proposed in the step *e* of the described automatic versioning algorithm in order to reduce the number of maps that be manually managed every time that LOINC® releases a new version. In details, they are plaining to design a solution that will allow understanding if the changes of the LOINC® entities are syntactic or semantic. By this way, in case of syntactic changes, the system could automatically validate the maps for the new version and could require the manual validation only for semantic changes. In addition, they want to design and develop an algorithm to check if the LOINC® codes selected in the mappings are correct. In fact, at the present all maps are manually processed. In the future, all maintenance functionalities will be adopted to manage other regional code systems as the regional catalog of prescription.

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