

# Semantics Management for a Regional Health Information System in Italy by CTS2 and FHIR

Roberta GAZZARATA<sup>a</sup>, Norbert MAGGI<sup>b,c</sup>, Luca Douglas MAGNONI<sup>a</sup>,  
Maria Eugenia MONTEVERDE<sup>a</sup>, Carmelina RUGGIERO<sup>a,b</sup> and  
Mauro GIACOMINI<sup>a,b,1</sup>

<sup>a</sup>*Healthropy S.r.l., Savona, Italy*

<sup>b</sup>*Department of Informatics, Bioengineering, Robotics and Information Systems,  
University of Genoa, Genoa, Italy*

<sup>c</sup>*Laboratory of Human Genetics, IRCCS Giannina Gaslini, Genova, Italy*

**Abstract.** An infrastructure for the management of semantics is being developed to support the regional health information exchange in Veneto – an Italian region which has about 5 million inhabitants. Terminology plays a key role in the management of the information fluxes of the Veneto region, in which the management of electronic health record is given great attention. An architecture for the management of the semantics of laboratory reports has been set up, adopting standards by HL7. The system has been initially developed according to the common terminology service release 2 (CTS2) standard and, in order to overcome complexities of CTS2 is being revised according to the Fast Healthcare Interoperability Resources (FHIR) standard, which has been subsequently introduced. Aspects of CST2 and of FHIR have been considered in order to retain most suitable aspects of both. This integration can be regarded as most worthwhile.

**Keywords.** Semantic interoperability, HL7, CTS2, FHIR

## 1. Introduction

Over the last 20 years health care delivery has gone through significant developments, mostly relating to electronic health records and data sharing, data standards, bioinformatics and public health informatics. Health informatics technologies are normally being evaluated according to three main aspects: the ability to improve health outcomes for patients, the care quality improvement and the reduction of health costs. In USA nearly 20% of the gross domestic product is used for healthcare, and this will not be sustainable in the future, which is also applicable to the rest of the world. Digital health is being implemented in clinical practice throughout the world, and the increasing cost of digital health technologies, together with a lower extent of regulations in the related markets may result in a further expansion and acceleration of their adoption [1].

Nowadays many problems have arisen for healthcare delivery, such as infectious disease surveillance, lack of personalized care, limitations in human resources,

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<sup>1</sup> Corresponding Author, Mauro Giacomini, via all'Opera Pia, 13 – 16145 Genova, Italy;  
E-mail: mauro.giacomini@dibris.unige.it..

inequitable distribution of health care. In 2018 WHO passed a resolution to develop digital health technology in order to promote equitable and universal access to health for all, and this was followed by the Global strategy on digital health 2020-2024 and by the national eHealth strategy toolkit, which was set up to help countries to integrate eHealth into their healthcare systems [2-5]. Subsequently, WHO provided recommendations on digital interventions for health system strengthening, based to address health system needs. As relates to implementation, the guideline by WHO also addresses problems for which digital health has the potential to help, such as distance and access, and shares many of the underlying challenges faced by health systems, such as poor management, infrastructural limitations and poor access to equipment [6].

Health information and communication technologies have been introduced, aiming to transform the organization of healthcare, improving quality of care and promoting access to affordable healthcare for all. At present the main modalities of digital health technologies electronic health records (EHRs), computerized provider order entry, health information exchange (HIE), Telemedicine/Telehealth, mobile-health, robots, virtual reality, wearable sensors, internet of things, artificial intelligence applications, machine learning [7].

HIE system adoption has increased worldwide in the last years, following the development and use of EHRs, which have most significant advantages with respect to paper records and whose development and use has been suggested as a key solution for the exchange of information among medical institutions and, in general, in healthcare systems [8-12]. HIE has a very high potential for health care information systems, both as relates to patient care and as relates to cost reduction for use of resources. Further research is needed to increase user participation and to develop further technology aspects [13]. Data sharing is a key building block for effective healthcare delivery. The main interacting systems that manage patient's data and could provide data for HIEs are EHRs, which store clinical information, such as patient's medical history, diagnoses, medications, laboratory results, which store and manage clinical laboratory data, and picture archiving and communication systems, which store and manage medical images.

Interoperability in eHealth has been addressed by the European Union (EU), which has set up the Refined eHealth European Interoperability Framework (EIF), which considers many different aspects of interoperability [14; 15].

An infrastructure for semantic interoperability is being developed to support the regional HIE in Veneto – an Italian region which has about 5 million inhabitants. This infrastructure aggregates data according to data semantics. The management of semantics is one of the key aspects of HIEs, because in medical practice terminologies used in different departments, laboratories and institutes are usually diverse and very different from standardized vocabularies, while standardized terminologies, universally recognized for each specific application domain, should be adopted [16-18].

## **2. Methods**

The Logical Observation Identifiers Names and Codes (LOINC) [19] vocabulary has been used, in order to represent concepts and relations among concepts which are defined in different local and standardized terminologies. LOINC is frequently updated, in order to maintain technologies and their relations up-to-date and coherent over time [20]. Concepts and terminologies relating to several laboratory tests in the Veneto Region have been encoded by LOINC. The results have been stored in a database and can be

downloaded by a table containing all laboratory tests and the related LOINC entities. The table has been uploaded in LISs, therefore LOINC codes have been used in the Clinical Documents Architecture (CDA) laboratory reports.

According to the recommendations by the Italian Health Ministry, standards by HL7 have been adopted. The CTS2 standard provides specifications to develop interfaces to manage, search and access terminology contents. CTS2 has been set up within the HL7 and Object Management Group initiative by the Healthcare Service Specification Project (HSSP) [20]. HSSP aims to define industry standards based on SOAs to achieve interoperability among applications that belong to independent socio-health system organizations [17; 21-23]. CTS2 defines elements called terminology resources and sets of operations, called functional profiles, which could be performed on them [24; 25].

In order to overcome the complexities of CTS2, HL7 has subsequently introduced the Fast Healthcare Interoperability Resources (FHIR), a standard aiming to improve healthcare information exchange using building blocks – called resources - which define common concepts, that is small units of data, such as observation, condition, device, patient. Resources increase the reusability of health information and are intended to cover typical use cases [26-28]. FHIR is increasingly adopted by technology companies and might see a faster adoption than other standards [27].

A terminology service has been developed for the Veneto, initially according to the CTS2 reference model. Subsequently the service has been integrated into a FHIR based system for terminology management, in order to improve speed and information reusability. Terminology plays a key role in the management of the information fluxes of the Veneto – in which the management of EHRs is given great attention. The adoption of a FHIR interface in the developed terminology system was due to the fact that Veneto Region adopted FHIR as its main semantic signifier for its Health Information Infrastructure (HII). Moreover, FHIR interface also improved the performances of the presented terminology system.

The CTS2 terminology resources that have been used are CodeSystem, CodeSystemVersion, EntityDescription, Map, MapVersion, MapEntry. For these elements the functional profiles Maintenance, Read, Query, History have been considered. The implementation profile that has been chosen is the Simple Object Access Protocol (SOAP), and the system has been hosted in Microsoft Windows Azure [18].

The system is being revised considering aspects of CTS2 and of FHIR, in order to retain the most suitable aspects of both to improve speed and reusability of information.

### **3. Results and Discussions**

The architecture for the management of the semantics of laboratory reports is shown in figure 1. Its main components are the Health Terminology Service (HTS), the client web application for the management of the information in the HTS, the Laboratory Information Systems (LISs) of the regional departments and regional HIE. The main component of the architecture is the HTS, which consists of a relational database in which all information relating to terminology resources is stored, and of a set of web services compliant with the CTS2 standard. The relational database is hosted in Microsoft SQL Azure. A set of web services provides access to the database by a CTS2 interface, consisting of a set of Windows Communication foundation (WCF) services hosted in Microsoft Azure [18]. Each terminology resource has one service for each functional profile, therefore the resulting HTS has 24 WCF services. Therefore, the FHIR

model has been adopted, which allows to replace the 24 WCF services with one FHIR resource. This significantly improves the speed of the system.

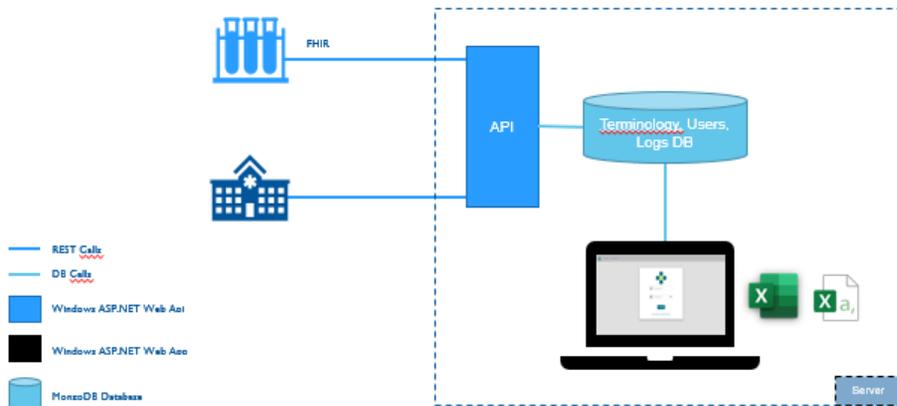


Figure 1. Architecture scheme

Other aspects have also been considered. The central database has CTS2 objects which resemble the FHIR ones, such as, the state of codes, which can be active or not. Moreover, a service which transmits FHIR messages has been added to the interface.

In conclusion, the integration of aspects of CTS2 and of FHIR can be regarded as most worthwhile. Further developments along these lines are being considered.

#### 4. Conclusions

The new HTS architecture based on FHIR message is still under test in work environment in Veneto Region, but preliminary results seem to be very promising, both as regards the speed performance of the system and for the capability of the system to maintain history of the terminology data sets, even at the concept/term level. This is probably due to the correct mixed use of the CTS2 features and of the FHIR specificities.

The correct use of a terminology system will significantly improve the use of HII that could be a fundamental tool to assure patients continuity of care and strengthen the delivery of territorial healthcare services.

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