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SAĞLIK-NET Project in Turkey and HL7 v3 Implementation

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***Abstract*—**This paper describes Clinical Document Architecture Release Two (CDA R2) standard and a client application for messaging with SAĞLIK-NET project developed by The Ministry of Health of Turkey. CDA R2 , developed by Health Level 7 (HL7) organization and approved by American National Standards Institute (ANSI) in 2004, to standardize medical information to be able to share semantically and syntactically. In this study, a client application compatible with HL7 V3 for a project named SAĞLIK-NET, aimed to build a National Health Information System by Turkey. Moreover, CDA conformance of this application will also be evaluated.

***Keywords*—**HL7 V3, CDA, Interoperability, Web Service.

I. Introduction

HEALTH Level Seven (HL7) it is an international standard initiated to share electronically information during health services in the health sector since 1987. It is still in the developmental stage and there are couple of versions (V2.x and V3.x) already. Clinical Document Architecture (CDA) Release Two(R2), developed by HL7 organization and approved by American National Standards Institute (ANSI) in 2004, to standardize medical information to be able to share semantically and syntactically. In this study, a client application compatible with HL7 V3 for a project named SAĞLIK-NET, aimed to build a National Health Information System by Turkey. Moreover, CDA conformance of this application will also be evaluated.

II. HL7 and CDA

HL7 follows the conceptual definition of application interface model in the seventh layer of the Open System Interconnection (OSI)[1]. The main theme of HL7 V2.x is that during two applications working, if a triggering event requiring communication occurs, two applications communicate [2]. For messaging there are message segments and vertical ASCII bars between segments (Fig. 1).

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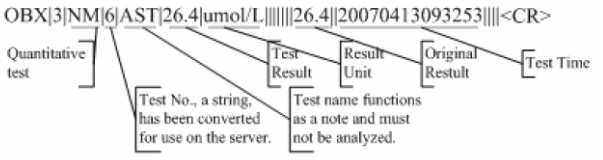

Fig. 1 HL7 v2.3.1 Observation Segment

Interoperability of HL7 v2.x become inadequate to be used in the complicated health care sector and to provide Computable Semantic Interoperability (CSI) HL7 V3 was developed [3]. Moreover, HL7 v3 was developed to the fact that;

- no information model for messaging,
- did not have a structure to include international coding systems such as Systematized Nomenclature of Medicine - Clinical Terms (SNOMED CT), Logical Observation Identifiers Names and Codes (LOINC), International Classification of Diseases (ICD),
- no working framework for Message Development Framework,
- no evaluating routines for the conformance of HL7
- HL7 v2.x has ability of optionality.

HL7's primary goal for Version 3 is to offer a standard that is definite and testable, and provide the ability to certify vendors' conformance. Version 3 uses an object-oriented development methodology and a Reference Information Model (RIM) to create messages. The RIM is an essential part of the HL7 Version 3 development methodology, as it provides an explicit representation of the semantic and lexical connections that exist between the information carried in the fields of HL7 messages [3]. The HL7 RIM is a critical component of the V3 development process. It is the root of all information models and structures developed as part of the V3 development process [4].

The HL7 V3 RIM defines the semantics of a set of common clinical, administrative, and financial data structures. More specifically, the HL7 V3 RIM defines a high-level backbone containing five abstract structural concepts (class):

- Entity: Things in the world, including place, organization material and living subject, either person or non-person.
- Role: Capability, capacity or competency, usually time-based.

- Participation: Role in the context of an act.
- Act: Clinical, administrative or financial definitions, plans, occurrences, and so forth.
- Act relationship: The semantics of links between acts.

The RIM provides a static view of the information needs of HL7 V3 standards. It includes class and state-machine diagrams and is accompanied by use case models, interaction models, data type models, terminology models, and other types of models to provide a complete view of the requirements and design of HL7 standards.

Organization of HL7 reported how messaging (Message Development Framework (MDF)) compatible with HL7 are to be carried out published[5]. According to this model, messaging event using story board is described. To make it more formal, firs stage completed using interaction diagrams. Then, starting from RIM, Hierarchical Message Definition (HMD) document is prepared. Finally application development starts depending on technology specification.

In this framework the goal of the messaging is to send the document using CDA.

The HL7 CDA is a document markup standard that specifies the structure and semantics of a clinical document (such as discharge summary, progress note, procedure report) for the purpose of exchange[6].

CDA R2, is highly interoperable in the health sector due to the features such as;

- Extensible Markup Language (XML) coding is used,
- It was totally driven from HL7 RIM,
- It uses HL7 data types,
- It has flexible structure,
- Its data can be handled by human or computer easily.

A. The Main Components of CDA Document and their Structures

A CDA document <ClinicalDocument.> has Header and Body sections. In the Header section there is information about unique description of the document; e.g. when and who created (Fig. 3). The body contains the clinical report and can be either an unstructured blob or can be comprised of structured markup. Fig. 3 shows a structured body, which is wrapped by the <structuredBody> element and is divided up into recursively nestable document sections. A CDA document section is wrapped by the <section> element. Each section can contain a single ''narrative block'' and any number of CDA entries and external references (Fig. 5, Fig. 6). The narrative block is a critical component of CDA and must contain the human readable content to be rendered. It is wrapped by the text element within the section. Element and contains XML markup [6,3].

CDA provides the mechanism to dress up the information in user's browser. It is called the narrative block. In the narrative block it is provided the representation of table, listed item, the size or property of text and so on. Fig. 2 shows the level of CDA. The higher level of CDA is more refined and formalized. In level 1 only plain text is just arranged not XML. In level 2, CDA is structured using XML and organized with narrative block. Level 2 is more formal than level 1 because of XML. In level 2, although a CDA body is well organized with XML, it is hard to process it automatically. Because it is not organized the consent itself. In level 3, the body information is structured by XML, and formalized by entry clinical statement classes. The clinical statement is a set of choices that are the classes of the RIM-derived. Each data item in clinical statement can be represented by entry. As a result, in level 3, every data items of narrative block is mapped to corresponding entry class. The meaning of every data item of CDA body can be formalized by entry is that users can see the clinical document as well as machine can process it. If the contents to be contained in narrative block can not be understood by other physician, it will be possible to check the entries. The entries explain the relationship of structure in clinical statement and contain the coded value.[7]

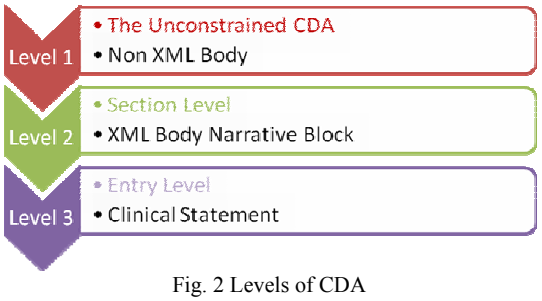

Fig. 2 Levels of CDA

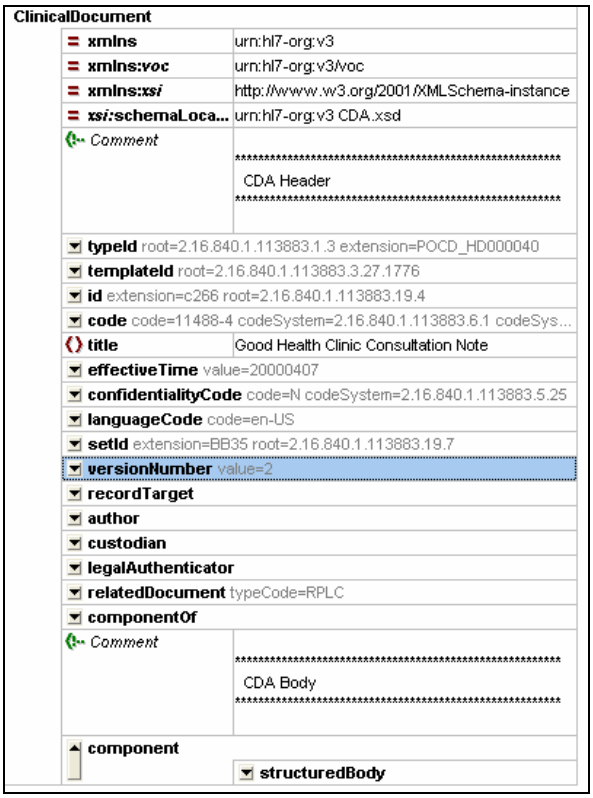

Fig. 3 CDA Header

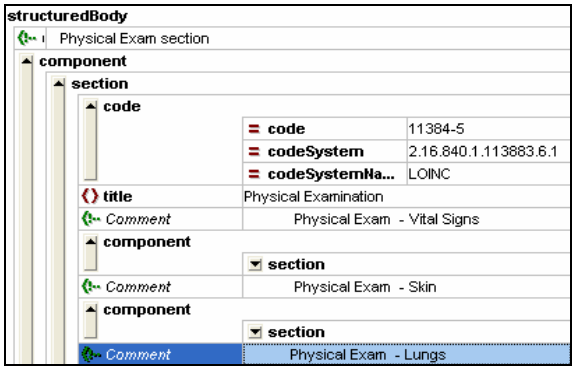

Fig. 4 CDA Body and Section

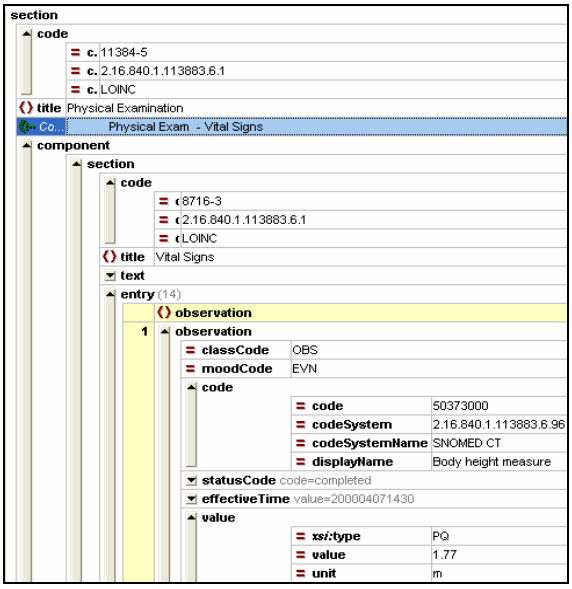

Fig. 5 CDA Section and Entries

```
<structuredBody>
  <!--  Physical Exam section-->
  <component>
    <section>
      <code code="11384-5"
      <title>Physical Examination</title>
      <!--          Physical Exam  - Vital Signs-->
      <component>
        <section>
          <code code="8716-3"
                codeSystem="2.16.840.1.113883.6.1"
                codeSystemName="LOINC"/>
          <title>Vital Signs</title>
          <entry>
            <observation classCode="OBS" moodCode="EVN"
              <code code="50373000"
                    codeSystem="2.16.840.1.113883.6.96"
                    codeSystemName="SNOMED CT"
                    displayName="Body height measure"/>
              <statusCode code="completed"/>
              <effectiveTime value="200004071430"/>
              <value xsi:type="PQ" value="1.77" unit="m">
            </observation>
          </entry>
          <entry>
          </section>
      </component>
    </section>
  </component>
</structuredBody>
```

Fig. 6 CDA Section and Entries as an XML View

As shown in Fig. 5 in the vital signs subsection of physical examination section height is given as an entry. There is also 14 more vital signs were also entered. (entry level 3). Narrative block is given as Level 2 (yellow area) to be seen more clearly in the browser. XML appearance of the same document was given in Fig. 6.

III. SAĞLIK-NET PROJECT

The project was described by The Ministry of Health of Turkey as an integrated reliable and fast information and communication platform which is capable collecting information in proper format from where it was created and producing proper information for shareholders in the health sector to increase quality and to obtain benefits. [8].

Ministry of Health of Turkey think that health data need to be collected fast and in proper forma to be able produce necessary policies and strategies. Therefore National Health Data Dictionary (NHDD) where information systems being used in the health departments in the country will be used as reference information.

Categorized data groups, hierarchical terms and object anthologies and relationships between these terms are described in this dictionary.

Moreover, description of coding and classification standards that those not categorized as a data dictionary but will be included in the Health Coding Reference Server (HCRS) will also be maintained.

In this aspect using NHDD and HCRS, collection of Minimum Health Data Sets (MHDS) are aimed by the SAĞLIK-NET project. During the formation of MHDS, ISO/IEC 11179-4 Formulation of data definition standard was used. Approximately 50 MHDS (e.g. inpatient, examination, birth, monitoring) are described in this module.

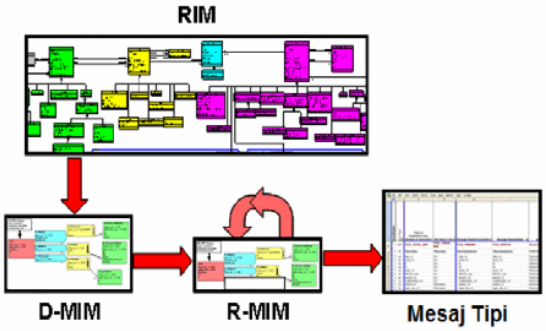

Fig. 7 Refinement Process for defining messages based on the HL7 RIM

IV. SAĞLIK-NET MESSAGING DESCRIPTION

The HL7 methodology uses RIM and the HL7-specified Vocabulary Domains as its starting point. It then establishes the rules for refining these base standards to arrive at the information structures that specify message types and equivalent structures in Version 3. Fig. 7 shows the refinement process specified in the methodology. Each red arrow in the diagram represents an application of the processes detailed in this section of the ballot. As

diagrammed, the processes are used to derive one or more Domain Message Information Models (D-MIM) from the RIM. Each such model represents the set of concepts applicable to a particular health care domain of interest. Within the domain, the Technical Committees use the same constraint process to derive one or more Refined Message Information Models (R-MIM) from the D-MIM for their domain. Finally, the committee applies the same constraints, coupled with a traversal of the information model graph, to arrive at the specification for an Hierarchical Message Descriptions (HMD) and its Message Types[3].

The Ministry of Health of Turkey published an integration manual for sending MSVS, which was prepared using object oriented MDF, in HL7 format. In this manual, R-MIM diagrams for each MHDS, documents of Web Service Description Language (WSDL) and necessary XML Schema Definitions (XSD) were included.

V. SAĞLIK-NET CLIENT APPLICATION AND CDA COMPATIBILITY

Application was developed using C#.NET. WSDL documents published were added as C# Web Reference, an example XML document of related MHDS were cast C# Web Reference object using deserialization.

After that, data made compatible to NHDD in the database of related department were transferred to the related Web Reference objects. Finally prepared message were sent to the SAĞLIK-NET. A message whose some parts were excluded to make it more understandable (Fig. 8).Clinical document of SAĞLIK-NET was examined and its differences from CDA R2 are given below;

A. Header

Instead of <ClinicDocument> term, a term telling about type of MHDS was used (e.g. <examination>, <diabetes>.) Then <title> attribute was not used for the header section. In order to form nested document sections the component element <component> was numbered as sub components (<component1> <component2>).

B. Body

Similarly instead of <section> element, a name proper for the dataset was used (<examinationDataset>). Instead of <entry> element, a proper name related to the entry information (e.g. <examProtocolNoSection>) was used (Fig. 8).

A document compatible with CDA R2 can be validated for HL7 dictionary, data types, document type and visual rendering [9].

Moreover, different Extensible Style Language (XSL) XML formatting documents can be observed in a browser (Fig. 9). Since structural data collecting is aimed with MHDS messaging, SAĞLIK-NET documents are formatted as CDA Level 3 entry.

SAĞLIK-NET aims to collect data that can be handled by its own system. The main feature of HL7 CDA R3 is that the data can be handled by human or computer easily.

```
<examination xmlns="urn:hl7-org:v3" classCode="DOCCLIN" moodCode="EVN">
  <versionNumber value="1"/>
  <recordTarget typeCode="RCT" contextControlCode="OP">
  <author typeCode="AUT" contextControlCode="OP">
  <custodian typeCode="CST">
  <primaryInformationRecipient typeCode="PRCP">
  <component typeCode="COMP" contextConductionInd="true">
    <structuredBody classCode="DOCBODY" moodCode="EVN">
      <component3 typeCode="COMP" contextConductionInd="true">
        <examinationDataset classCode="DOCSECT" moodCode="EVN">
          <examProtocolNoSection classCode="DOCSECT" moodCode="EVN">
            <examProtocolNo classCode="ACT" moodCode="EVN">
              <id root="2.16.840.1.113883.3.129.1.1.4" extension="A080001000"/>
            </examProtocolNo>
          </component>
        </examProtocolNoSection>
      </component1>
      <component2 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:nil="
      <component3 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:nil="
```

Fig. 8 SAĞLIK-NET CDA R2 Referenced Document Sample

Patient:	**Henry Levin , the 7th**
Kontakt:	
geb.:	24. September 1932
Behandelnder Arzt:	Robert Dolin , MD

Good Health Clinic Consultation Note

History of Present Illness

Henry Levin, the 7th is a 67 year old male referred for further a

Past Medical History

- Asthma
- Hypertension (see HTN.cda for details)
- Osteoarthritis, right knee

Social History

- Smoking :: 1 PPD between the ages of 20 and 55, and then he quit.
- Alcohol :: rare

Physical Examination

Vital Signs

Date / Time	April 7, 2000 14:30	April 7, 2000 15:30
Height	177 cm (69.7 in)	
Weight	194.0 lbs (88.0 kg)	

Fig. 9 Visually Rendered HL7 CDA R2 Compatible Document

VI. CONCLUSION

National Health Information System (NHIS) proposed to be formed by SAĞLIK-NET project can be considered a positive step. Application of HL7 V3 method in the health sector data collection has been an important experience. Planning, providing and observing health care services are very important for the national economy as well. In order to obtain results at desired levels, national and international standards should be used to collect and evaluate data in such a dynamic health sector. These implications can also indicate how important the project is.

HL7 V3 message developing and message transferring profile (Web Service) seem to be proper selections. Hundreds of health organizations and their information system providers are trying hard to send data in proper format for this project. This approach presented here will help them to prepare data structure and data collection schemes driving them from financial level to medical level.

SAĞLIK-NET project ignore compatibility to HL7 CDA R2 while giving emphasis to clinical document transfer. It is unfortunity that an important application developed only for the project while it can also be used in other sections of the health sector. If HL7 CD R2 was supported fully for the messaging, then it could also be used for data exchange among and between departments, other health care organizations or international organizations.

CDA compatible document can be seen easily by web browser and can be evaluated by the computers, the project which is still developing should have taken this aspect into consideration.

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