Information Exchange Standards

Mike Henderson
Principal Consultant, Eastern Informatics, Inc.
Co-Chair, HL7 Education Work Group
Section A

DL7, DICOM, and Structured Documents
Topics

- Standards used in integration
- HL7 overview and domains
- DICOM overview and domains
- The IHE initiative
- Messaging architectures and examples
Standards Used in Integration

- **Messaging standards**
  - HL7
    - Version 2 (ad hoc)
    - Version 3 (model-based)
  - DICOM
  - IETF, ITU-T, NTP, ASTM, W3C, etc.

- **Controlled vocabulary standards**
  - SNOMED, ICD-10, CPT-4, Read, etc.

- **Architecture and communications standards**
  - ISO OSI, TCP/IP, etc.
HL7 Overview

- HL7 definition and purpose
- Brief history
- Domains
How HL7 Began

- **Precursor: ASTM E1238 standard**
  - Standardized in mid 1980s
  - Dr. Clem McDonald, Regenstrief Institute
  - Pathology results

- **HL7’s first meeting**
  - University of Pennsylvania, March 1987
  - Dr. Sam Schultz
  - Initial domain specifications
  - Message formats: delimited vs. tagged
Why Health Level Seven?
- Rests atop the Application layer of the ISO Open System Interconnect model
- There is no HL1-HL6
- Lower layers and handshaking addressed outside the normative standard
**Mission**
- To provide standards for the exchange, management, and integration of data that support clinical patient care and the management, delivery, and evaluation of health care services

**Primary goal**
- To provide standards for the exchange of data among health care computer applications that eliminate or substantially reduce the custom interface programming and program maintenance that may otherwise be required
Objectives

- The standard should support exchanges among systems implemented in the widest variety of technical environments
- Immediate transfer of single transactions should be supported along with file transfers of multiple transactions
- The greatest possible degree of standardization should be achieved, consistent with site variations in the usage and format of certain data elements
- The standard must support evolutionary growth as new requirements are recognized
- The standard should be built upon the experience of existing production protocols and accepted industry-wide standard protocols
Objectives

- While it is both useful and pertinent to focus on information systems within hospitals, the long-term goal should be to define formats and protocols for computer applications in all health care environments.

- The very nature of the diverse business processes that exist within the health care delivery system precluded the immediate development either of a universal process or of a data model:
  - No a priori assumptions about the architecture of health care information systems
  - No attempt to resolve architectural differences between health care information systems
  - Version 2 not a true “plug and play” interface standard
■ Objectives
  - Infrastructure supports a consensus balloting process in order to facilitate quick deployment of the standard
  - Cooperation with other related health care standards is a priority
    ▶ DICOM
    ▶ ASC X12
    ▶ ASTM
    ▶ IEEE/MEDIX
    ▶ NCPDP
  - Conformance profiling mechanism (Chapter 2B)
How Messages Are Structured in HL7 Version 2

- Messages are made up of segments
- Each segment contains one or more fields of defined data types
- Fields can contain components and subcomponents
- Using default encoding, delimiters are specified in the MSH (message header) segment
How Messages Are Structured in HL7 Version 2

MSH|^~\&|MegaReg|UABHospC|ImgOrdMgr|UABImgCtr|20070529090131-0500||ADT^A01|01052901|P|2.5

EVN||200705290901||200705290900

PID||56782445^^^UAReg^PI~999855750^^^USSSA^SS||KLEINSAMPLE^BARRY^Q^JR||19620910|M||2028-9^^HL70005^RA99113^^XYZ|260 GOODWIN CREST DRIVE^^BIRMINGHAM^AL^35209^^H|||0105I30001^^^99DEF^AN

PV1||I|W^389^1^UABH^^^^3|||12345^MORGAN^REX^J^^^^MD^0010^UAMC^L|||67890^GRAINGER^LUCY^X^^^^MD^0010^UAMC^L|MED|||A0|||13579^POTTER^SHERMAN^T^^^^MD^0010^UAMC^L|MED|||A0|||200705290900

OBX|1|NM|^Body Height||1.80|m^Meter^ISO+|||F

OBX|2|NM|^Body Weight||79|kg^Kilogram^ISO+|||F

AL1|1||^ASPIRIN
HL7 Standards Development Process (V2)

- Proposals from users submitted to HL7 Web site
- Assigned to appropriate work groups for discussion
- Participants: volunteers—users, vendors, consultants, payers
  - Periodic t-cons/meetings out-of-cycle
- Work groups meet face to face three times annually at working group meetings
- Balloted for inclusion in omnibus revisions to HL7 V2 standard
  - Next revision: V2.8
HL7 Standards Development Process (V3)

- Basis: Reference Information Model (RIM)
  - Clinical Document Architecture based on subsets of RIM

- Proposals for model changes and additional artifacts submitted to appropriate work groups

- Participants: volunteers—users, vendors, consultants, payers

- Work groups meet face to-face three times annually at working group meetings
  - Periodic t-cons/meetings out-of-cycle

- Changes proposed by work group are harmonized with the model as a whole

- Balloted for inclusion in domain-specific incremental revisions to the V3 standard
A clinical document is a record of observations and other services with the following characteristics:

- Persistence
- Stewardship
- Potential for authentication
- Wholeness
- Human readability

CDA documents are encoded in Extensible Markup Language (XML)
Clinical Document Architecture (CDA)

- CDA documents derive their meaning from the RIM and use HL7 v3 data types

- A CDA document consists of a header and a body
  - **Header** is consistent across all clinical documents
    - It identifies and classifies the document, and provides information on the patient, provider, encounter, and authentication
  - **Body** contains narrative text/multimedia content (level 1), optionally augmented by coded equivalents (levels 2 and 3)
CDA Release 2 Information Model

Header

Body

Participants

Doc ID & Type

Context

Sections/Headings

Clinical Statements/Coded Entries

Extl Refs

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Continuity of Care Document (CCD)

- Based on the HL7 Clinical Document Architecture, Release 2 (CDA) specification in accordance with requirements set forward in ASTM E2369-05 Standard Specification for Continuity of Care Record (CCR)

- Alternate implementation to the one specified in ASTM ADJE2369 for those institutions or organizations committed to implementation of the HL7 Clinical Document Architecture
Continuity of Care Document (CCD)

- Continuity of Care Record (CCR) is a core data set of the most relevant administrative, demographic, and clinical information facts about a patient’s health care, covering one or more health care encounters.

- CCD provides a means for one health care practitioner, system, or setting to aggregate all of the pertinent data about a patient and forward it to another practitioner, system, or setting to support the continuity of care.

- CCD is just one type of CDA document.
  - Other types of CDA documents can contain some of the same CCD sections—but different sections as well.
HITSP CDA Content Modules (C83)

- A library of sections that can be combined into various CDA document types

- A document type can include additional sections, even those not a part of it
  - A CCD could add a Reason for Referral section and still be a valid CCD
  - “HITSP Data Dictionary” describes the data elements and the constraints (optionality, repeatability, and value sets) for each data element in the structured data portions of C83
HITSP C32 (CCD Component)

- Describes the document content summarizing a consumer’s medical status for the purpose of information exchange.

- Content may include:
  - Administrative information (e.g., registration, demographics, insurance, etc.) and
  - Clinical information (problem list, medication list, allergies, test results, etc.)

- Defines content in order to promote interoperability between participating systems.

- Any given system creating or consuming the document may contain much more information than conveyed by the C32 specification.
CDA Narrative and Coded Info

- CDA structured body requires human-readable “Narrative Block,” all that is needed to reproduce the legally attested clinical content

- CDA allows optional machine-readable coded “Entries,” which drive automated processes

- Narrative may be flagged as derived from Entries
  - Textual rendering of coded entries’ content and contains no clinical content not derived from the entries

- General method for coding clinical statements is a hard, unsolved problem
  - CDA allows incremental improvement to amount of coded data without breaking the model
History of Present Illness

Henry Levin, the 7th, is a 67 year old male referred for asthma in his teens. He was hospitalized twice last year, been able to be weaned off steroids for the past several

Past Medical History

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

Medications

```xml
<title>Past Medical History</title>
- <text>
  - <list>
    - <item>
      <content ID="a1">Asthma</content>
    </item>
  + <item>
  + <item>
  </list>
</text>
- <entry>
  - <observation classCode="COND" moodCode="EVN">
    <code code="39154008">
      codeSystem="2.16.840.1.113883.6.96"
      codeSystemName="SNOMED CT" displayName="clinical diagnosis" />
    <effectiveTime value="1950" />
    - <value xsi:type="CD" code="195967001">
      codeSystem="2.16.840.1.113883.6.96"
      codeSystemName="SNOMED CT" displayName="Asthma" />
      - <originalText>
        <reference value="#a1" />
    </value>
  </observation>
```
DICOM Overview

- DICOM defined
- Brief history
- Domains
How DICOM Began

- Evolution of imaging in the 1970s
  - Introduction of digital diagnostic imaging modalities (e.g., computerized tomography)
  - Increasing use of computers in medical applications

- Joint committee formed in 1983
  - American College of Radiology (ACR)
  - National Electrical Manufacturers Association (NEMA)

- Version 1 released 1985

- Version 2 released 1988

- Version 3 released 2001
DICOM Defined (Formally)

- Promotes communication of digital image information regardless of device manufacturer
- Facilitates the development and expansion of picture archiving and communication systems (PACS) that can also interface with other systems of hospital information
- Allows the creation of diagnostic information data bases that can be interrogated by a wide variety of devices distributed geographically
DICOM Defined (Operationally)

- Facilitates interoperability of medical imaging equipment by specifying:
  - A set of protocols to be followed by devices claiming conformance to the standard
  - The syntax and semantics of commands and associated information which can be exchanged using these protocols
  - Information that must be supplied with an implementation for which conformance to the standard is claimed
DICOM Defined (Operationally)

Does not specify:
- The implementation details of any features of the standard on a device claiming conformance
- The overall set of features and functions to be expected from a system implemented by integrating a group of devices each claiming DICOM conformance
- A testing/validation procedure to assess an implementation’s conformance to the standard
## DICOM Example: C-STORE Message—DICOM Part 7

### Table 9.3-1: C-STORE-RQ MESSAGE FIELDS

<table>
<thead>
<tr>
<th>Message Field</th>
<th>Tag</th>
<th>VR</th>
<th>VM</th>
<th>Description of Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command Group Length</td>
<td>(0000,0000)</td>
<td>UL</td>
<td>1</td>
<td>The even number of bytes from the end of the value field to the beginning of the next group.</td>
</tr>
<tr>
<td>Affected SOP Class UID</td>
<td>(0000,0002)</td>
<td>UI</td>
<td>1</td>
<td>SOP Class UID of the SOP Instance to be stored.</td>
</tr>
<tr>
<td>Command Field</td>
<td>(0000,0100)</td>
<td>US</td>
<td>1</td>
<td>This field distinguishes the DIMSE-C operation conveyed by this Message. The value of this field shall be set to 0001H for the C-STORE-RQ Message.</td>
</tr>
<tr>
<td>Message ID</td>
<td>(0000,0110)</td>
<td>US</td>
<td>1</td>
<td>Implementation-specific value. It distinguishes this Message from other Messages.</td>
</tr>
<tr>
<td>Priority</td>
<td>(0000,0700)</td>
<td>US</td>
<td>1</td>
<td>The priority shall be set to one of the following values: LOW = 0002H; MEDIUM = 0000H; HIGH = 0001H</td>
</tr>
<tr>
<td>Data Set Type</td>
<td>(0000,0800)</td>
<td>US</td>
<td>1</td>
<td>This field indicates that a Data Set is present in the Message. It shall be set to any value other than 0101H (Null).</td>
</tr>
<tr>
<td>Affected SOP Instance UID</td>
<td>(0000,1000)</td>
<td>UI</td>
<td>1</td>
<td>Contains the UID of the SOP Instance to be stored.</td>
</tr>
<tr>
<td>Move Originator Application Entity Title</td>
<td>(0000,1030)</td>
<td>AE</td>
<td>1</td>
<td>Contains the DICOM AE Title of the DICOM AE which invoked the C-MOVE operation from which this C-STORE sub-operation is being performed.</td>
</tr>
<tr>
<td>Move Originator Message ID</td>
<td>(0000,1031)</td>
<td>US</td>
<td>1</td>
<td>Contains the Message ID (0000,0110) of the C-MOVE-RQ Message from which this C-STORE sub-operations is being performed.</td>
</tr>
<tr>
<td>Data Set</td>
<td>(no tag)</td>
<td>¾</td>
<td>¾</td>
<td>Application-specific Data Set.</td>
</tr>
</tbody>
</table>

**Message Header (Transport Wrapper)**

**Information Object**
## General Study Module Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Instance UID</td>
<td>(0020,000D)</td>
<td>1</td>
<td>Unique identifier for the Study.</td>
</tr>
<tr>
<td>Study Date</td>
<td>(0008,0020)</td>
<td>2</td>
<td>Date the Study started.</td>
</tr>
<tr>
<td>Study Time</td>
<td>(0008,0030)</td>
<td>2</td>
<td>Time the Study started.</td>
</tr>
<tr>
<td>Referring Physician’s Name</td>
<td>(0008,0090)</td>
<td>2</td>
<td>Name of the patient's referring physician.</td>
</tr>
<tr>
<td>Referring Physician Identification</td>
<td>(0008,0096)</td>
<td>3</td>
<td>Identification of the patient's referring physician. Only a single item shall be</td>
</tr>
<tr>
<td>Identification Sequence</td>
<td></td>
<td></td>
<td>permitted in this sequence.</td>
</tr>
<tr>
<td>Study ID</td>
<td>(0020,0010)</td>
<td>2</td>
<td>User or equipment generated Study identifier.</td>
</tr>
<tr>
<td>Accession Number</td>
<td>(0008,0050)</td>
<td>2</td>
<td>A RIS generated number that identifies the order for the Study.</td>
</tr>
<tr>
<td>Study Description</td>
<td>(0008,1030)</td>
<td>3</td>
<td>Institution-generated description or classification of the Study (component) performed.</td>
</tr>
<tr>
<td>Physician(s) of Record</td>
<td>(0008,1048)</td>
<td>3</td>
<td>Names of the physician(s) who are responsible for overall patient care at time of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Study (see Section C.7.3.1 for Performing Physician)</td>
</tr>
</tbody>
</table>

>Include ‘Person Identification Macro’ Table 10-1
### DICOM Example: Study ID Attribute

#### DICOM Part 6

<table>
<thead>
<tr>
<th>Tag</th>
<th>Name</th>
<th>VR</th>
<th>VM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0020,000D)</td>
<td>Study Instance UID</td>
<td>UI</td>
<td>1</td>
</tr>
<tr>
<td>(0020,000E)</td>
<td>Series Instance UID</td>
<td>UI</td>
<td>1</td>
</tr>
<tr>
<td>(0020,0010)</td>
<td>Study ID</td>
<td>SH</td>
<td>1</td>
</tr>
<tr>
<td>(0020,0011)</td>
<td>Series Number</td>
<td>IS</td>
<td>1</td>
</tr>
<tr>
<td>(0020,0012)</td>
<td>Acquisition Number</td>
<td>IS</td>
<td>1</td>
</tr>
<tr>
<td>(0020,0013)</td>
<td>Instance Number</td>
<td>IS</td>
<td>1</td>
</tr>
</tbody>
</table>

#### DICOM Part 5

<table>
<thead>
<tr>
<th>SH</th>
<th>Description</th>
<th>Default Character Repertoire and/or as defined by (0008,0005).</th>
<th>16 chars maximum (see NOTE in 6.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH</td>
<td>Short String</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A character string that may be padded with leading and/or trailing spaces.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The character code 05CH (the BACKSLASH &quot;&quot; in ISO-IR 6) shall not be present,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>as it is used as the delimiter between values for multiple data elements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The string shall not have Control Characters except ESC.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>16 chars maximum (see NOTE in 6.2)</td>
<td></td>
</tr>
<tr>
<td>SL</td>
<td>Signed Long</td>
<td>not applicable</td>
<td>4 bytes fixed</td>
</tr>
<tr>
<td></td>
<td>Signed binary integer 32 bits long in 2's complement form.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Represents an integer, n, in the range:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-2^{31} &lt;= n &lt;= (2^{31} - 1).]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SQ</td>
<td>Sequence of Items</td>
<td>not applicable</td>
<td>not applicable</td>
</tr>
<tr>
<td></td>
<td>Value is a Sequence of zero or more Items, as defined in Section 7.5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>Signed Short</td>
<td>not applicable</td>
<td>2 bytes fixed</td>
</tr>
<tr>
<td></td>
<td>Signed binary integer 16 bits long in 2's complement form.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Represents an integer n in the range:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-2^{15} &lt;= n &lt;= (2^{15} - 1).]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Key Aspects of DICOM Structured Reports (SR)

- SR documents are encoded using DICOM standard data elements and leverage DICOM network services (storage, query/retrieve).

- SR uses DICOM Patient/Study/Series information model (header), plus hierarchical tree of “Content Items”.

- Extensive mandatory use of coded content
  - Allows use of vocabulary/codes from non-DICOM sources.

- Templates define content constraints for specific types of documents/reports.
DICOM SR Example

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DICOM SR Example

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DICOM SR Example

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DICOM SR Example

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DICOM SR Example

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DICOM SR Example

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DICOM SR Object Classes

- **Basic Text:** narrative text with image references

- **Enhanced and Comprehensive:** text, coded content, numeric measurements, spatial and temporal ROI references

- **CAD:** automated analysis results (mammo, chest, colon)

- **Key Object Selection (KO):** flags one or more images
  - Purpose (for referring physician, for surgery ...) and textual note
  - Used for key image notes and image manifests (in IHE profiles)

- **Procedure Log:** for extended duration procedures (e.g., cath)

- **Radiation Dose Report:** projection X-ray; CT
DICOM Standards Development Process

- Administered by NEMA

- Volunteer working groups meet on varying schedules (one to several times per annum)

- Participants: volunteers from subject matter domain

- Change proposals and new supplements are balloted and / or issued for trial implementation

- Ballot-approved proposals are included in the next annual edition of the standard