XML Technology in HL7's Patient Medical Record Information Exchanges*

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Robert H. Dolin, MD

Kaiser Permanente

***Disclaimer: Opinions are those of the author. XML activities have not yet been subjected to HL7's formal ballot process.**

Outline

- **Introduction to XML**
- **XML Healthcare Applications**
  - Medical Publishing
  - Messaging
  - Clinical Documents
- **Conclusions**

Introduction to XML

XML embeds <BOLD> **tags** </BOLD> in documents.
These tags tell a computer how to process a document.

- **SGML**
  - User-defined tags.
  - A set of user-defined tags apply to a class of documents.
- **HTML**
  - A fixed set of tags.
  - Uses the rules of SGML to define its set of tags.
  - The set of HTML tags are used in all HTML documents on the World Wide Web.
- **XML**
  - User-defined tags that apply to a class of documents.
  - A formal (simpler) subset of SGML.

HTML is SGML (although not XML)

```
<h2>Patient Information</h2>
<ul>
    <li><b>Name:</b>Henry Levin, the 7th</li>
    <li><b>MRN:</b>123456789</li>
    <li><b>DOB:</b>May 13, 1900</li>
</ul>

<h2>Clinical Data</h2>
<p>History of smoking for 40 years.

<h2>Procedure</h2>
<p>Chest X-ray

<h2>Findings</h2>
<p>Comparison is made with a chest-x-ray …

<h2>Impressions</h2>
<p>RLL nodule, suggestive of malignancy. Compared with a prior CXR from 6 months ago, nodule size has increased.

<h2>Recommendations</h2>
<p>I notified the ordering physician of this finding by phone.
```

Radiology Report - Chest X-Ray

Patient Information
- **Name:** Henry Levin, the 7th
- **MRN:** 123456789
- **DOB:** May 13, 1900

Clinical Data
History of smoking for 40 years.

Procedure
Chest X-Ray

Findings
Comparison is made with a chest x-ray ...

Impressions
RLL nodule, suggestive of malignancy. Compared with a prior CXR from 6 months ago, nodule size has increased.

Recommendations
I notified the ordering physician of this finding by phone.

XML - Define your own tags

```
<RadiologyReport>

<PatientInfo>
    <Name>Henry Levin, the 7th</Name>
    <MRN>123456789</MRN>
    <DOB>May 13, 1900</DOB>
</PatientInfo>

<ClinicalData>History of smoking for 40 years. </Clinica

<Procedure>Chest X-ray</Procedure>

<Findings>Comparison is made with a chest-x-ray …
</Findings>

<Impressions>RLL nodule, suggestive of malignancy.
    Compared with a prior CXR from 6 months ago, nod
    size has increased.
</Impressions>

<Recommendations>I notified the ordering physician of
    this finding by phone.
</Recommendations>

</RadiologyReport>
```

Radiology Report - Chest X-Ray

Patient Information
- **Name:** Henry Levin, the 7th
- **MRN:** 123456789
- **DOB:** May 13, 1900

Clinical Data
History of smoking for 40 years.

Procedure
Chest X-Ray

Findings
Comparison is made with a chest x-ray
…

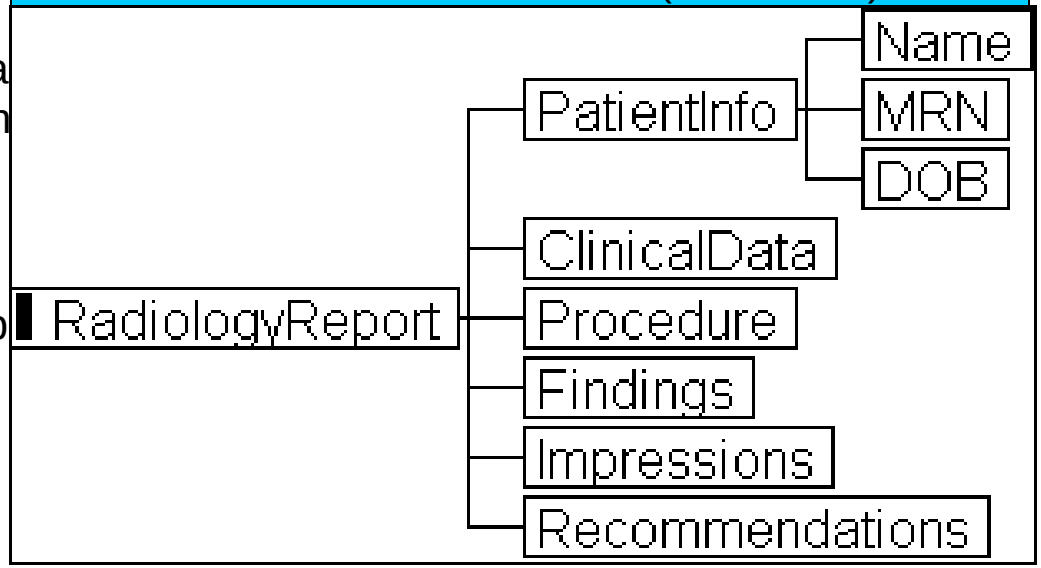
Impressions
RLL nodule, suggestive of malignancy. Compared with a prior CXR from 6 months ago, nodule size has increased.

Recommendations
I notified the ordering physician of this finding by phone.

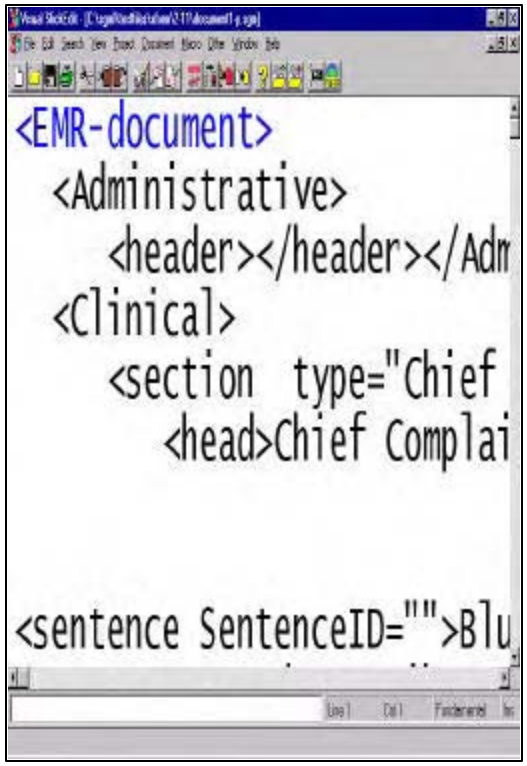
XML - Define your own tags

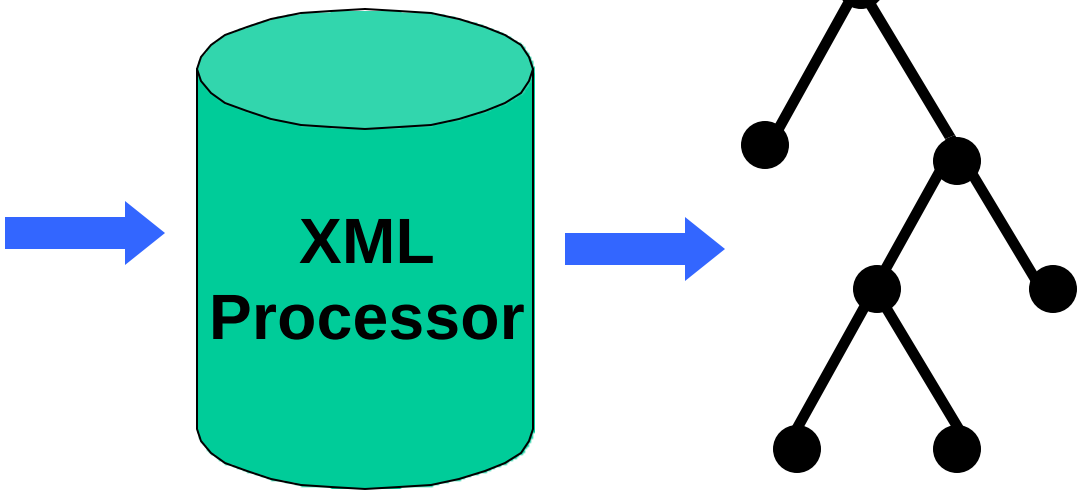
```
<RadiologyReport>

<PatientInfo>
    <Name>Henry Levin, the 7th</Name>
    <MRN>123456789</MRN>
    <DOB>May 13, 1900</DOB>
</PatientInfo>

<ClinicalData>History of smoking for 40 year

<Procedure>Chest X-ray</Procedure>

<Findings>Comparison is made with a chest-
</Findings>

<Impressions>RLL nodule, suggestive of ma
    Compared with a prior CXR from 6 month
    size has increased.
</Impressions>

<Recommendations>I notified the ordering p
    this finding by phone.
</Recommendations>

</RadiologyReport>
```

```
<!ELEMENT RadiologyReport
      (PatientInfo, ClinicalData,
       Procedure, Findings, Impressions,
       Recommendations)>
<!ELEMENT PatientInfo
      (Name, MRN, DOB)>
<!ELEMENT Name                (#PCDATA)>
<!ELEMENT MRN                 (#PCDATA)>
<!ELEMENT DOB                 (#PCDATA)>
<!ELEMENT ClinicalData        (#PCDATA)>
<!ELEMENT Procedure           (#PCDATA)>
<!ELEMENT Findings            (#PCDATA)>
<!ELEMENT Impressions         (#PCDATA)>
<!ELEMENT Recommendations     (#PCDATA)>
```



XML - Computer-processable documents





XML reduces a document (or message) to a word in a known context-free grammar through a process of markup.

History of XML in HL7

- **1986 SGML**
  - ISO 8879:1986
- **1996 SGML Initiative**
  - The original vision and charter for the deployment of SGML in healthcare was developed by John Mattison and John Spinosa.
- **1996 HL7 SGML/XML Special Interest Group**
  - HL7 Presidents Ed Hammond and Woody Beeler strongly support inclusion of SGML/XML activities within HL7.
  - Co-chairs: John Mattison, Rachael Sokolowski, Paul Biron, Liora Alschuler.
  - Objectives:
    - Coordinate the development of a comprehensive document architecture for healthcare;
    - Educate the healthcare community in the capabilities and utility of SGML/XML;
    - Investigate the use of SGML/XML as a messaging syntax
- **1998 XML**
  - Approved Feb ‘98 by W3C

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Medical Publishing

- **What?**
  - Textbooks
  - Journal Articles
  - Clinical Guidelines
  - Pharmacy, Lab Manuals
- **Why?**
  - Rapid wide-spread deployment
  - Consistency in content and presentation
  - Enhanced search performance
  - Application-independent persistent format

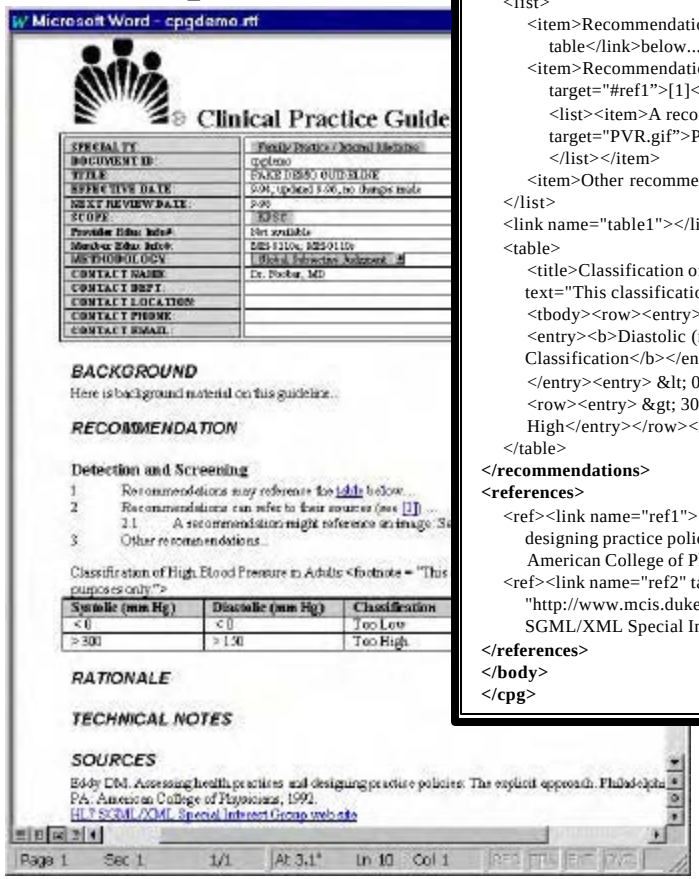
in XML

```
<cpg>
<head>
   <specialty>Family Practice/Internal Medicine</specialty>
   <number>cpgdemo </number>
   <document.title>FAKE DEMO GUIDELINE</document.title>
   <effective.date>9-94; updated 9-96, no changes made</effective.date>
   <review.date>9-98</review.date>
   <scope> KPSC </scope>
   <format>kpscal_cpg_v1.0 </format>
   <provider.education>Not available</provider.education>
   <member.education>MH-0110e; MH-0110s</member.education>
   <methodology>Global Subjective Judgment</methodology>
   <contact.person>Dr. Foobar, MD </contact.person>
</head>
<body>
<background>
   <para>Here is background material on this guideline... </para>
</background>
<recommendations>
   <subsection> Detection and Screening</subsection>
   <list>
      <item>Recommendations may reference the <link target="#table1”>
         table</link>below...</item>
      <item>Recommendations can refer to their sources (see <link
         target="#ref1”>[1]</link>)...
         <list><item>A recommendation might reference an image: See <link
         target="PVR.gif”>Pressure-Volume Relationships</link></item>
         </list></item>
      <item>Other recommendations...</item>
   </list>
   <link name="table1”></link>
   <table>
      <title>Classification of High Blood Pressure in Adults <footnote
      text="This classification scheme is for demo purposes only.”></title>
      <tbody><row><entry><b>Systolic (mm Hg)</b></entry>
      <entry><b>Diastolic (mm Hg)</b></entry><entry><b>
      Classification</b></entry></row><row><entry> &lt; 0
      </entry><entry> &lt; 0 </entry><entry>Too Low </entry> </row>
      <row><entry> &gt; 300</entry><entry> &gt; 150</entry><entry>Too
      High</entry></row></tbody>
   </table>
</recommendations>
<references>
   <ref><link name="ref1”></link>Eddy DM. Assessing health practices and
      designing practice policies: The explicit approach. Philadelphia, PA:
      American College of Physicians; 1992. </ref>
   <ref><link name="ref2" target =
      "http://www.mcis.duke.edu/standards/HL7/committees/sgml/”> HL7
      SGML/XML Special Interest Group web site</link></ref>
</references>
</body>
</cpg>
```

Transform

Transform

in Template



in HTML

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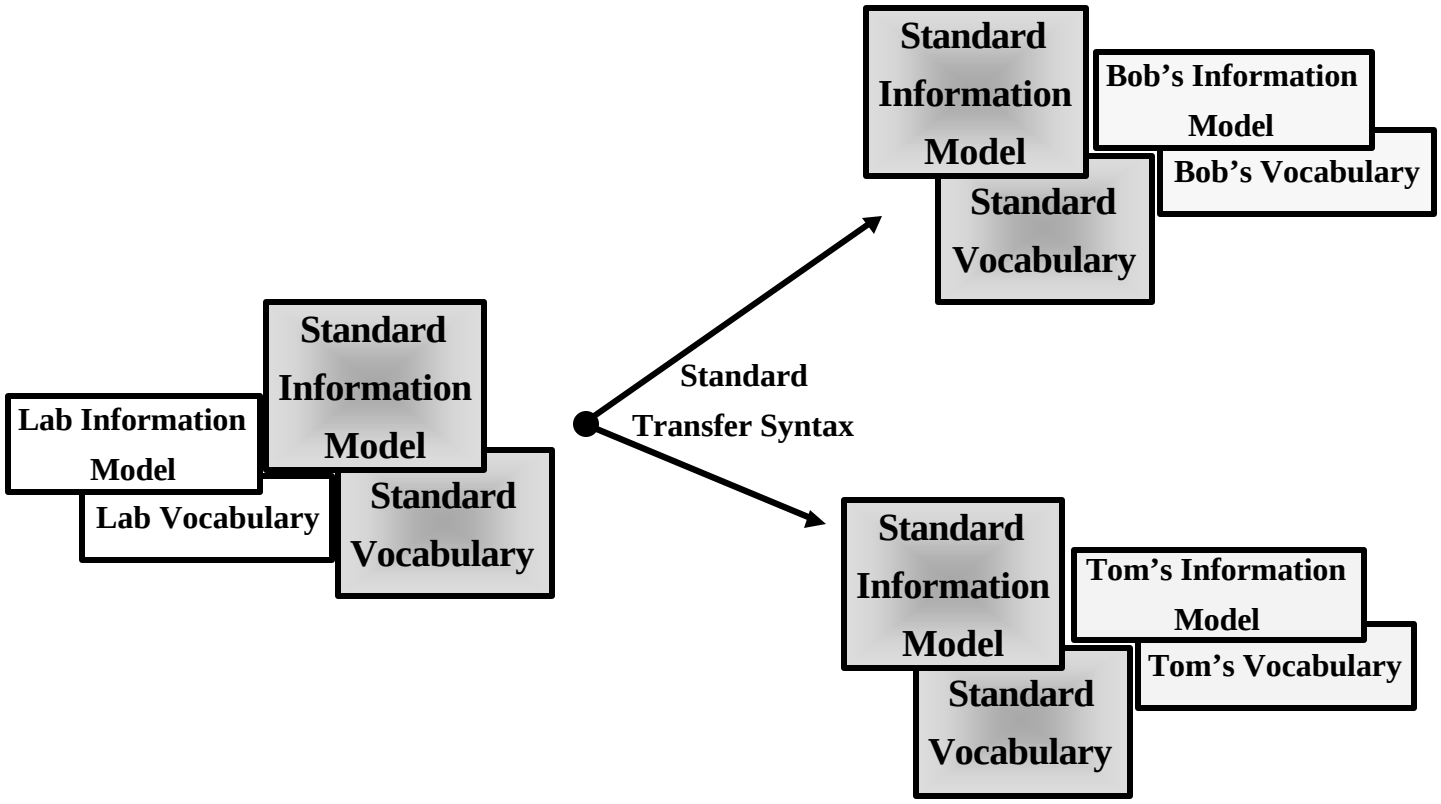
Messaging

Data Exchange: The unambiguous standards-based transfer of data between applications.



Transfer Syntax: The explicit expression of the sender's semantics in a format that can be understood by the receiver.

History of XML for HL7 messages

- **1993 CEN Report**
  - "Investigation of Syntaxes for Existing Interchange Formats to be used in Healthcare" (ASN.1,ASTM E1238, EDIFACT, EUCLIDES, ODA).
  - Based on example scenarios, general message requirements are determined. Each syntax is examined to see which of the general requirements can be fulfilled.
  - Metrics include:
    Supported Information Structures
    Supported Data Types
    Encoding
    Evolution and Backwards Compatibility
    Conformance
    Support and Availability
- **1997 SGML as a Messaging Syntax**
  - Robert Dolin, et al extend the CEN report, using their scenarios and evaluation criteria, to include SGML.
  - SGML compares favorably with other syntaxes studied by CEN.
  - No syntax explicitly represents all functional requirements.
- **1999 HIMSS Demonstration**
  - Wes Rishel coordinates a 10-vendor HL7-XML interoperability demo.
  - All vendors rated the demo a success.

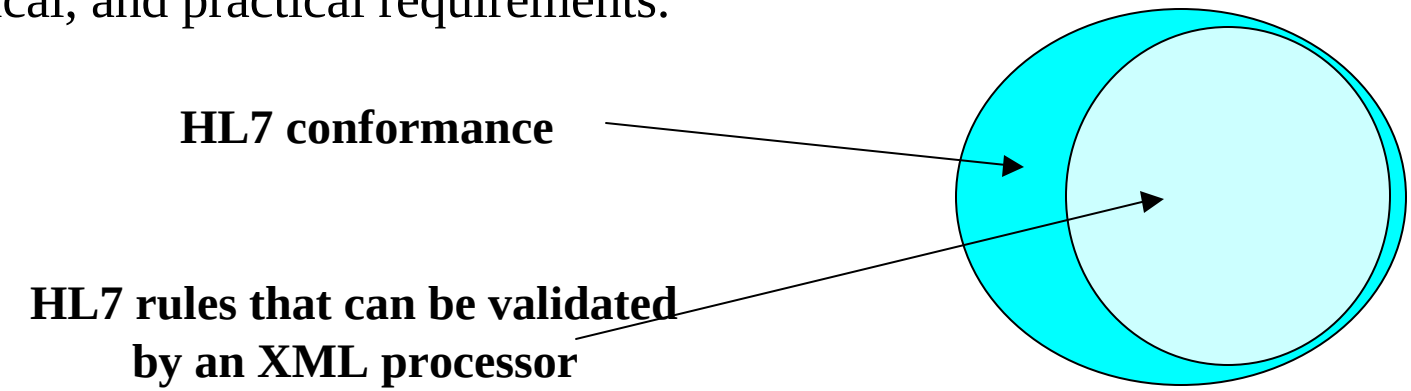
Messaging - HL7 V2.3 message

```
MSH|^~\&||||||ORU^R01<cr>
OBR||123456789||
    |P3-72990^Growth hormone measurement^SNM3<cr>
OBX||ST|2963-7^SOMATOTROPIN:MCNC:PT:SER:QN^LN|
    |3.5|ng/mL|0-5<cr>
```

```
<ORU.R01>
<MSH>
  <MSH.1>|</M
  <MSH.2>^~\&
  <MSH.9><MSH.9.CM.1>ORU</MSH.9.CM.1>
         <MSH.9.CM.2>R01</MSH.9.CM.2></MSH.9>
</MSH>
<OBR>
  <OBR.2><EI.1>123456789</EI.1></OBR.2>
  <OBR.4><CE.1>P3-72990</CE.1>
         <CE.2>Growth hormone measurement</CE.2>
         <CE.3>SNM3</CE.3></OBR.4>
</OBR>
<OBX>
  <OBX.2>ST</OBX.2>
  <OBX.3><CE.1>2963-7</CE.1>
         <CE.2>SOMATOTROPIN:MCNC:PT:SER:QN</CE.2>
         <CE.3>LN</CE.3></OBX.3>
  <OBX.5>3.5</OBX.5>
  <OBX.6><CE.1>ng/mL</CE.1></OBX.6>
  <OBX.7>0-5</OBX.7>
</OBX>
</ORU.R01>
```

HL7-XML Messaging: Findings

- XML can serve as an implementable syntax for HL7 V2.3 and V3 messages.
- XML messages will be longer then today's HL7 messages.
- The ability to express an HL7 rule in an XML DTD confers the ability to validate that rule with an XML processor.
- Not all HL7 requirements can be validated by an XML processor. Validation of these HL7 business rules will rely on further message processing by another application.
- Mapping HL7 into XML uncovered areas of ambiguity with the HL7 Standard.
- The optimal message representation is a balance of functional, technical, and practical requirements.



HL7-XML Messaging: Status

- **Version 2.3**
  - XML-ification being prepared as an Informative Document.
  - XML style will be similar to that being proposed for Version 3.
- **Version 3**
  - XML will be used as a transfer syntax.

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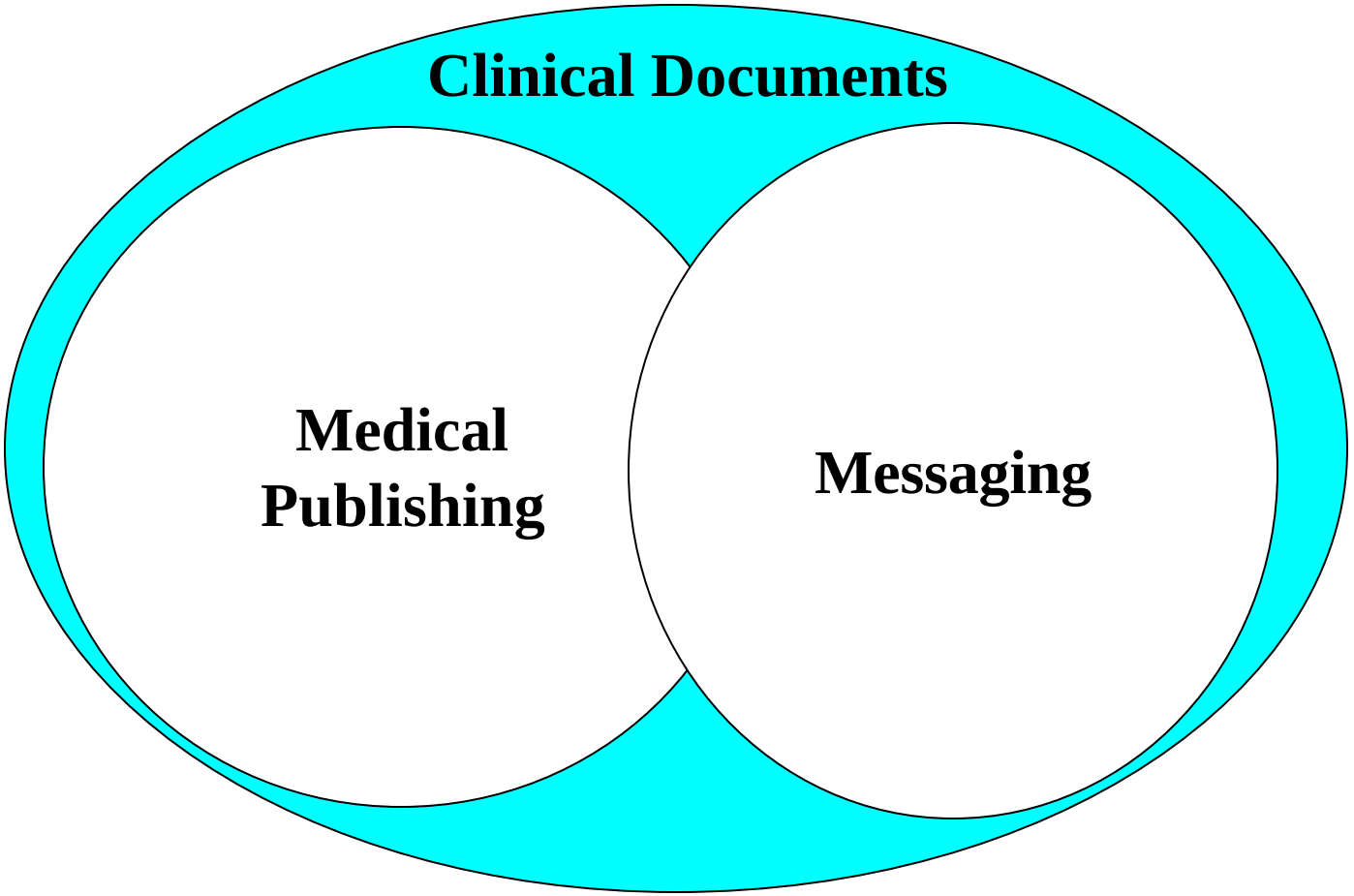
Clinical Documents



HL7 Document Patient Record Architecture

- **Healthcare is document-centric**
  - Considerable clinical content is contained in narrative notes, which are created on systems of widely varying characteristics.
  - It is difficult to store and/or exchange documents with retention of computer-processable semantics over both time and distance.
  - Capturing some of the semantics of clinical narratives for computer processing is better then capturing none; capturing more of the semantics is better then capturing less; and if you know something and don't record it, you've lost it.
  - The HL7 Document Patient Record Architecture proposes a common data architecture that can accommodate a diverse set of records and requirements.

HL7 Document Patient Record Architecture

- **XML provides a SYNTAX for HL7 SEMANTICS**
  - XML tags have no predefined semantic meaning.
  - Interoperability requires a shared semantics.
  - Document processing is determined by an application that understands the meaning of the tags.
  - HL7 PRA XML tags derive their meaning from the HL7 Reference Information Model (as do all HL7 V3 messages)
  - HL7 PRA Documents provide for a standardized way of referencing external vocabularies.

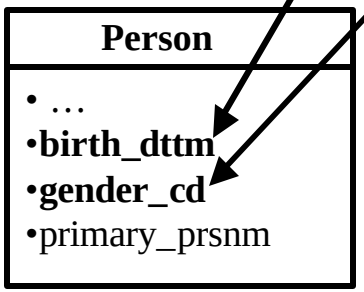
What's in a <name>?

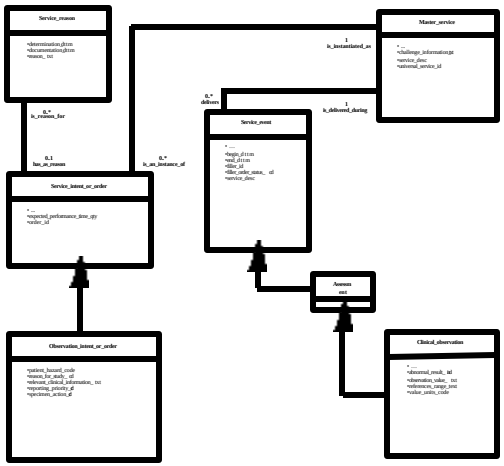
```
<RadiologyReport>

<PatientInfo>
    <Name>Henry Levin, the 7th</Nam
    <MRN>123456789</MRN>
    <DOB>May 13, 1900</DOB>
</PatientInfo>

<ClinicalData>History of smoking for 4

<Procedure>Chest X-ray</Procedure

<Findings>Comparison is made with a
</Findings>

<Assessment>RLL nodule, suggestiv
    Compared with a prior CXR from 6
    size has increased.
</Assessment>

<Recommendations>I notified the ordering physician of
    this finding by phone.
</Recommendations>

</RadiologyReport>
```

```
<radiology.report>
<header>
    <name>Henry Levin, the 7th</name>
    <dob>19000513</dob>
    <patient.id>123456789</patient.id>
</header>
<body>
    <section title = "Procedure">
        <healthcare.code identifier="P5-20100"
          name.of.coding.system="SNM3">
          Chest X-Ray</healthcare.code>
    </section>
    <section title = "Impressions">
        <user.text>RLL nodule, suggestive of
          malignancy.</user.text>
    </section>
...
</body>
</radiology.report>
```

HL7 PRA is harmonized with the RIM

HL7 Reference Information Model



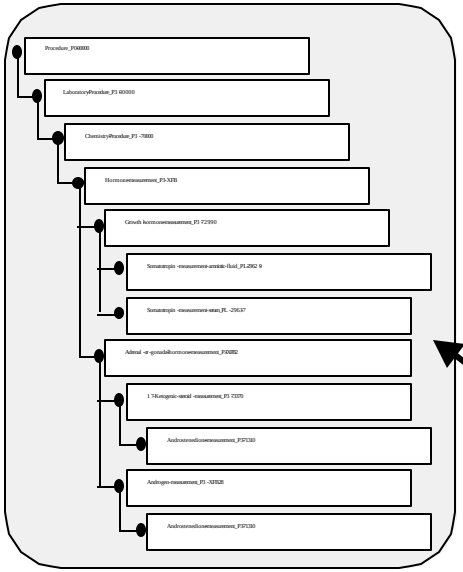


```
<!ELEMENT RadiologyReport (PatientInfo, …)>
<!ELEMENT PatientInfo (Name, MRN, DOB, SEX)>
<!ELEMENT DOB %Time_stamp;>
<!ATTLIST DOB
   HL7.datatype CDATA #FIXED "TS"
   RIM.attribute CDATA #FIXED "Person.birth_dttm">
<!ELEMENT SEX EMPTY>
<!ATTLIST SEX
   HL7.datatype CDATA #FIXED "ID”
   RIM.attribute CDATA #FIXED "Person.gender_cd"
   domain CDATA #FIXED "HL70001"
   value %sex.table; #REQUIRED >
…
```

```
<RadiologyReport>
<PatientInfo>
    <Name>Henry Levin, the 7th</Name>
    <DOB>19000513</DOB>
    <SEX value=“Male”/>
</PatientInfo>
<Impressions>
    RLL <healthcare.code identifier=“M-03010”
    coding.system=“SNM3”> nodule
    </healthcare.code>, suggestive of malignancy...
</Impressions>
</RadiologyReport>
```

HL7 PRA references standard terminologies

SNOMED Terminology Model



```
<!ELEMENT RadiologyReport (PatientInfo, …)>
<!ELEMENT PatientInfo (Name, MRN, DOB, SEX)>
<!ELEMENT DOB %Time_stamp;>
<!ATTLIST DOB
   HL7.datatype CDATA #FIXED "TS"
   RIM.attribute CDATA #FIXED "Person.birth_dttm">
<!ELEMENT SEX EMPTY>
<!ATTLIST SEX
   HL7.datatype CDATA #FIXED "ID”
   RIM.attribute CDATA #FIXED "Person.gender_cd"
   domain CDATA #FIXED "HL70001"
   value %sex.table; #REQUIRED >
…
```

```
<RadiologyReport>
<PatientInfo>
    <Name>Henry Levin, the 7th</Name>
    <DOB>19000513</DOB>
    <SEX value=“Male”/>
</PatientInfo>
<Impressions>
    RLL <healthcare.code identifier=“M-03010”
    coding.system=“SNM3”> nodule
    </healthcare.code>, suggestive of malignancy...
</Impressions>
</RadiologyReport>
```

HL7 Document Patient Record "Architecture"

Generic PRA LevelOne DTD

- **Generic PRA LevelTwo DTD**
  - DTD LevelTwo Endocrinology
    - DTD LevelTwo Endocrinology Diabetes
      - DTD LevelThree Endocrinology Diabetes
    - DTD LevelThree Endocrinology
      - DTD LevelThree Endocrinology Diabetes
  - DTD LevelTwo FamilyMedicine
    - DTD LevelTwo FamilyMedicine Diabetes
  - DTD LevelTwo Diabetes
    - DTD LevelTwo Endocrinology Diabetes
      - DTD LevelThree Endocrinology Diabetes
    - DTD LevelTwo FamilyMedicine Diabetes
    - DTD LevelThree Diabetes
      - DTD LevelThree Endocrinology Diabetes
  - **Generic PRA LevelThree DTD**
    - DTD LevelThree Endocrinology
      - DTD LevelThree Endocrinology Diabetes
    - DTD LevelThree Diabetes
      - DTD LevelThree Endocrinology Diabetes

Mapping a local DTD into PRA

```
<RadiologyReport>

<PatientInfo>
    <Name>Henry Levin, the 7th</Nam
    <MRN>123456789</MRN>
    <DOB>May 13, 1900</DOB>
    <SEX>M</SEX>
</PatientInfo>

<Procedure>
    Chest X-ray
</Procedure>

<Impressions>
    RLL <healthcare.code
    identifier="M-03010"
    coding.system="SNM3">
    nodule </healthcare.code>,
    suggestive of malignancy...
</Impressions>

</RadiologyReport>
```

```
<radiology.report>
<header>
    <name>Henry Levin, the 7th</name>
    <dob>19000513</dob>
    <sex value="Male"/>
    <patient.id>123456789</patient.id>
</header>
<body>
    <section title="Procedure">
        Chest X-ray
    </section>
    <section title="Assessment">
        <user.text>RLL nodule, suggestive of
          malignancy.</user.text>
        <concept ID="1" code="M03010"
          text="nodule" source="SNM3"/>
        <concept ID="2" code="M80001"
          text="malignancy" source="SNM3"/>
        <relationship ID1="1" ID2="2"
          code="GC022" text="suggests"
          source="SNM3"/>
    </section>
</body>
</radiology.report>
```

The PRA Editorial Group

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XML Technology in HL7's Patient Medical Record Information Exchanges

- **Conclusions**
  - XML is a sound technology, valuable for exchange of messages and documents.
  - XML is an application-independent format valuable for the persistent storage of documents.
  - XML documents are easily web-deployed.
  - Rapid industry growth of XML tools will facilitate HL7 implementations.
  - Rapid growth of interest in XML helps attract attention to the need for shared semantics.
  - XML can provide a standardized syntax for the expression of shared semantics.
  - XML validation represents an HL7 conformance metric.

XML Technology in HL7's Patient Medical Record Information Exchanges

- **What role should the government play?**
  - Medical content is complex, and no organization has yet produced a complete or widely accepted model. Timelines for national PMRI-Exchange standards should balance the need for implementation with the need for deepening our shared understanding of clinical information. This balance should ensure that quality standards can continue to evolve, and not be hampered by early rollout of awkward standards. The architectural approach put forth in the HL7 PRA proposal is one way of achieving this balance.
  - There are limitations to mapping between different information models. If Standards Development Organizations (SDOs) independently create DTDs, information exchange will be limited by the extent to which those DTDs conform to a shared model. If all groups creating DTDs were encouraged to derive them from PRA, then many barriers to effective information exchange would be minimized. This holds for groups within HL7, SDOs, professional and regulatory groups, providers and vendors.
  - Grants for SDOs (e.g. HL7, NIHI) and grants for large scale validation of clinical data models will accelerate standards development.