ComView
MEDICAL SYSTEMS

DICOM SR: Object Model

DICOM Structured Reporting: An Object Model as an Implementation Boundary

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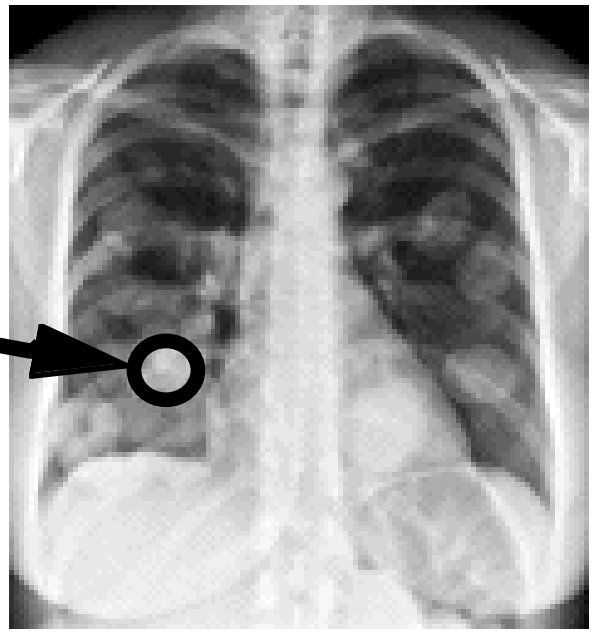
Overview

- What are the features of a DICOM SR ?
- What are the applications ?
- What can be learned from Internet ?
- Representation-independent APIs:
  - Object model
  - Event stream
- Re-use DOM or SAX or SR-specific ?

Headings, Findings, Images, Codes

Chest X-ray Report:
Recording Observer: Clunie^David^A^Dr.
History: malignant melanoma excised 1Y
Findings:
- finding: multiple masses in both lung fields
- best illustration of findings:



Conclusions:
- conclusion: cannon-ball metastases
- conclusion: recurrent maligant melanoma

Diagnosis Codes:
- diagnosis: 172.9/ICD9
- diagnosis: 197.0/ICD9

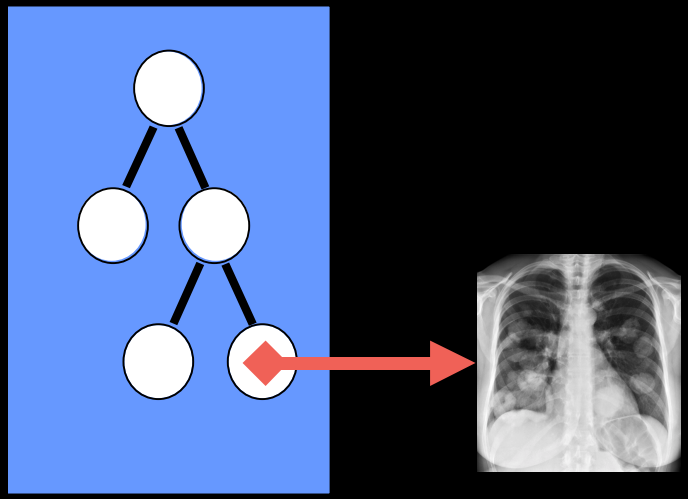
DICOM SR Features

- Tree of “nodes” (content items)
- Each node is a “name-value” pair
- Types of values:
  - Code, text, numeric, dates & times, names, coordinates, references (images, etc.)
- Representation is binary DICOM tags

DICOM SR: Object Model

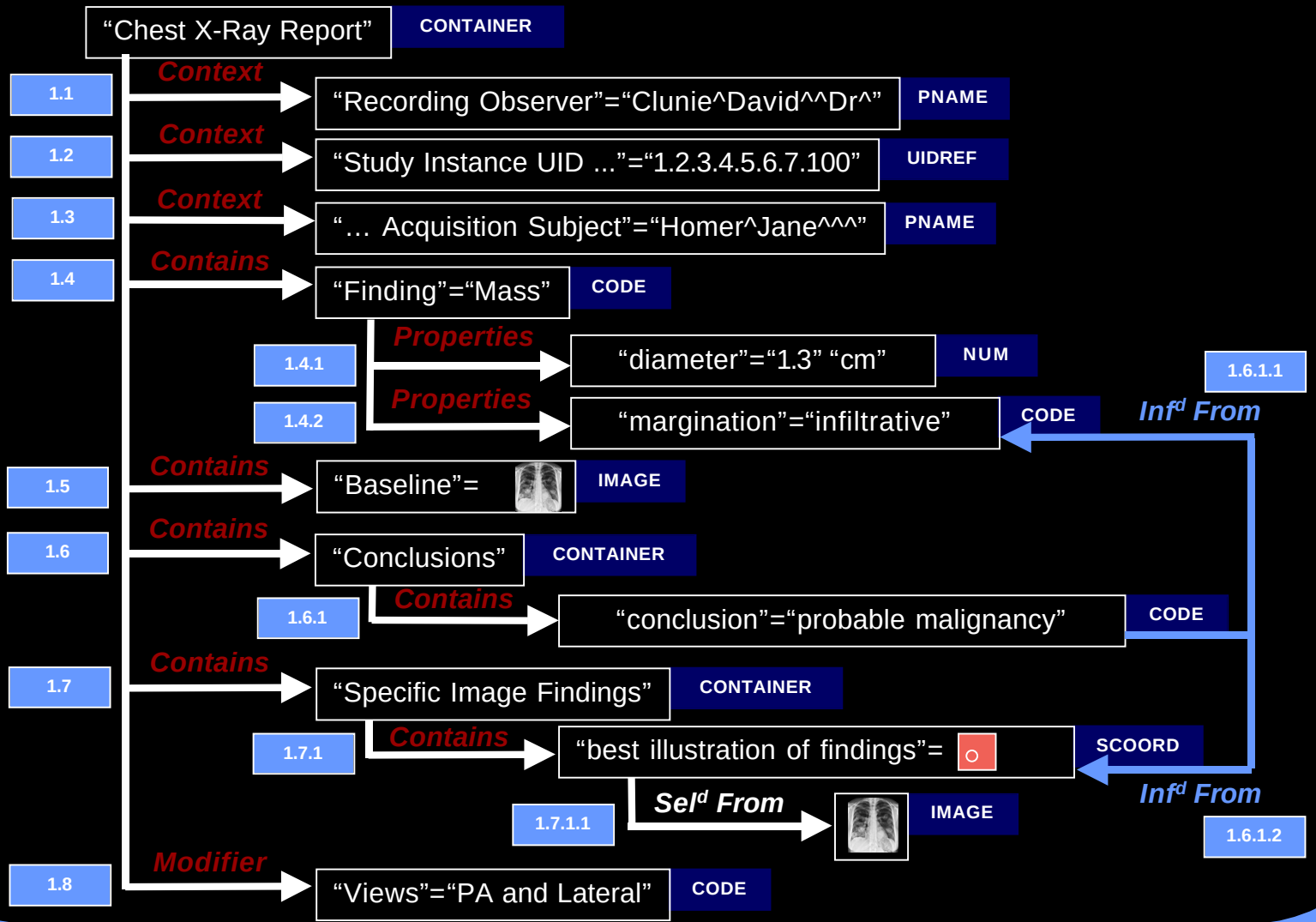
Sup 23: Structured Reporting

(0x0040,0xa491) <COMPLETE>
(0x0040,0xa493) <VERIFIED>
(0x0040,0xa730) Content Sequence
(0x0040,0xa010) <HAS OBS CONTEXT>
(0x0040,0xa040) <PNAME >
(0x0040,0xa043) Concept Name Code Sequence
(0x0008,0x0100) <000555>
(0x0008,0x0102) <LNdemo>
(0x0008,0x0104) <Recording 0bserver>
(0x0040,0xa123) <Smith^John^^Dr^ >
...



Hierarchical structure, codes, image references

DICOM SR: Object Model



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DICOM SR: Object Model

Application Requirements

- Create and edit SR reports
- Render SR reports
- Trans-code into other standards:
  - HL7 2.x ORU messages/OBX segments
  - Clinical Document Architecture (CDA)
- Print formatted text
- Archive and query report content

DICOM SR: Object Model

Implementation Requirements

- Creation of structured content
  - GUI
  - Natural language parsing (NLP)
- Encoding/parsing of “serialized” representation (as DICOM object)
- Trans-coding & rendering of same content

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DICOM SR: Object Model

Expertise Requirements

- GUI and/or NLP
- DICOM
- Rendering and formatting

Methodology: separate different domain expertise by well-defined API boundaries.

Internet Lessons

- Structured content:
  - XML
  - APIs: DOM & SAX
- Trans-coding:
  - XSL-T
- Rendering:
  - HTML, CSS, JavaScript …

DICOM SR: Object Model

Same Model: Different Representation

(0x0040,0xa491) <COMPLETE>
(0x0040,0xa493) <VERIFIED>
(0x0040,0xa730) Content Sequence
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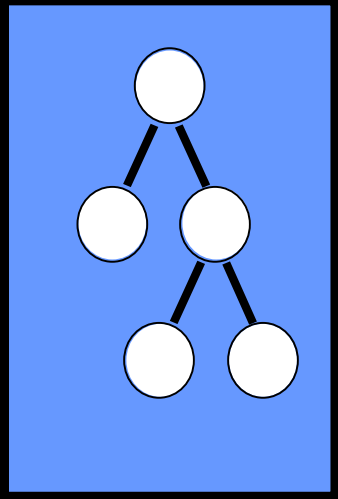
(0x0008,0x0102) <LNdemo>
(0x0008,0x0104) <Recording 0bserver>
(0x0040,0xa123) <Smith^John^^Dr^ >
...

DICOM



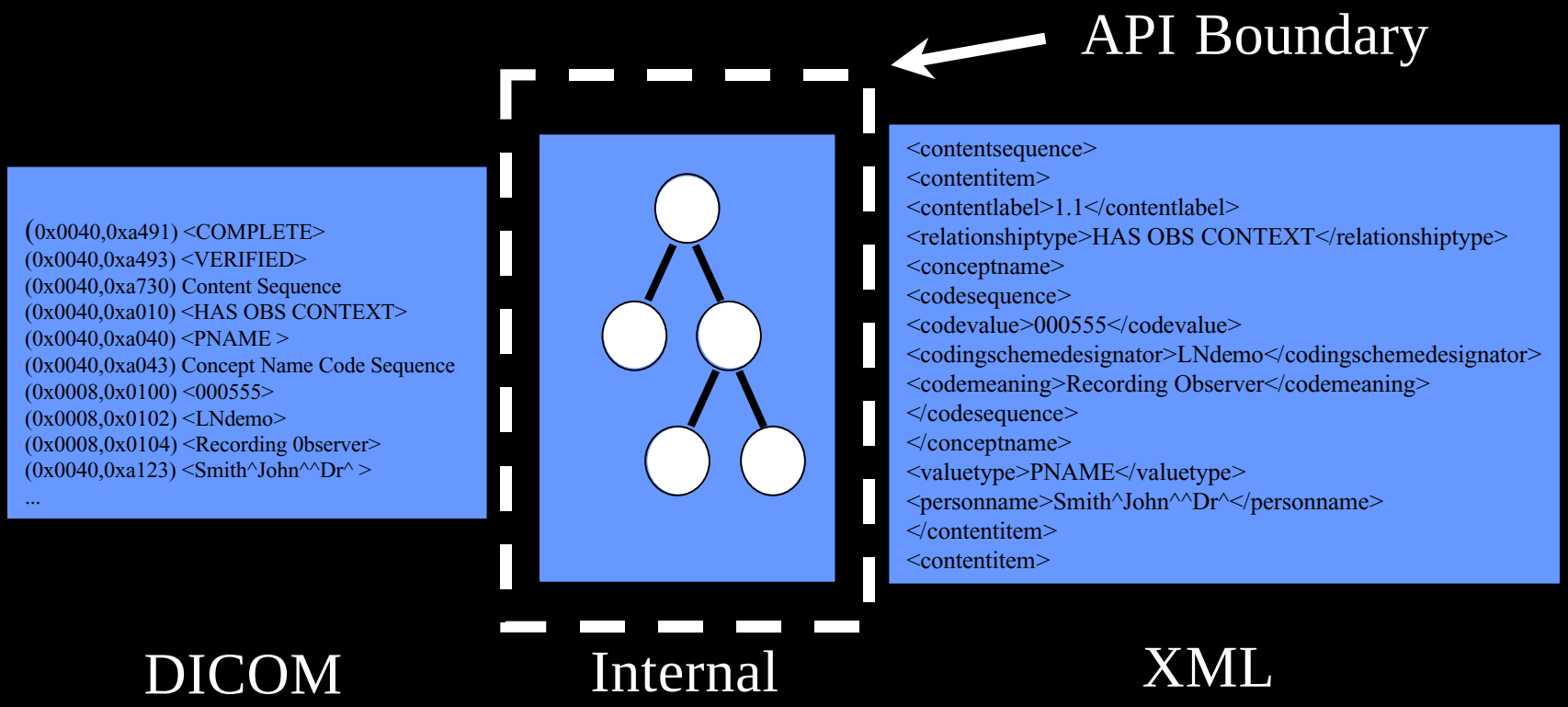
Internal

```
<contentsequence>
<contentitem>
<contentlabel>1.1</contentlabel>
<relationshiptype>HAS OBS CONTEXT</relationshiptype>
<conceptname>
<codesequence>
<codevalue>000555</codevalue>
<codingschemedesignator>LNdemo</codingschemedesignator>
<codemeaning>Recording Observer</codemeaning>
</codesequence>
</conceptname>
<valuetype>PNAME</valuetype>
<personname>Smith^John^^Dr^</personname>
</contentitem>
<contentitem>
```

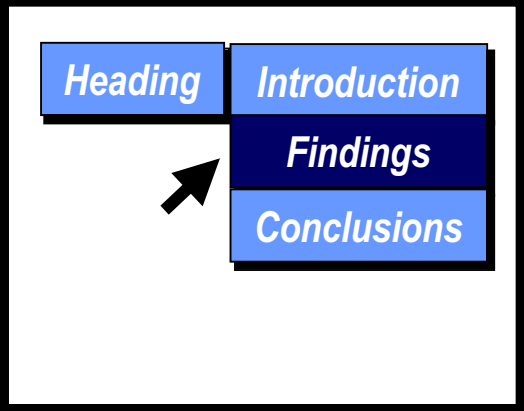
XML

DICOM SR: Object Model

Same Model: API Boundary

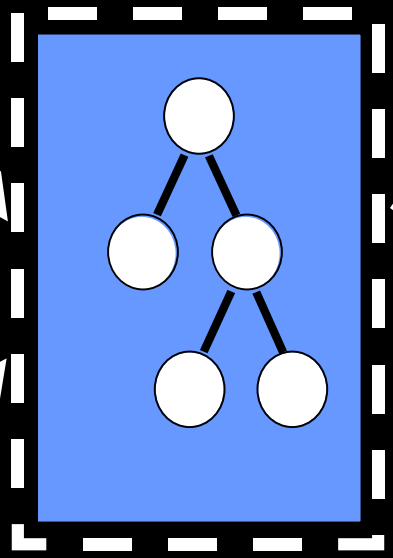


DICOM SR: Object Model



GUI A

Encoder C



(0x0040,0xa491) <COMPLETE>
(0x0040,0xa493) <VERIFIED>
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(0x0008,0x0102) <LNdemo>
(0x0008,0x0104) <Recording 0bserver>
(0x0040,0xa123) <Smith^John^^Dr^ >
...

Report of Chest X-Ray (PA and LateralViews)

Patient Jane Homer
Study # 123456
Recorded by Dr. John Smith

The finding is a mass measuring 1.3 cm in diameter with an infiltrative margination.

NLP B

Encoder D

<contentsequence>
<contentitem>
<contentlabel>1.1</contentlabel>
<relationshiptype>HAS OBS CONTEXT</relationshiptype>
<conceptname>
<codesequence>
<codevalue>000555</codevalue>
<codingschemedesignator>LNdemo</codingschemedesignator>
<codemeaning>Recording Observer</codemeaning>

Common API

DICOM SR: Object Model

DICOM

(0x0040,0xa491) <COMPLETE>
(0x0040,0xa493) <VERIFIED>
(0x0040,0xa730) Content Sequence
(0x0040,0xa010) <HAS OBS CONTEXT>
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(0x0040,0xa043) Concept Name Code Sequence
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(0x0040,0xa123) <Smith^John^^Dr^ >
...

<contentsequence>
<contentitem>
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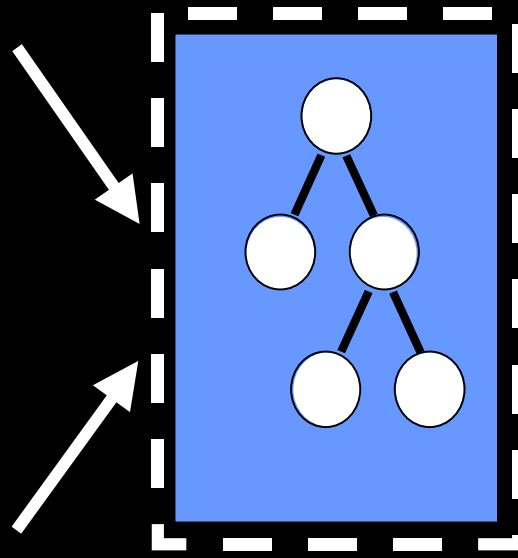
<relationshiptype>HAS OBS CONTEXT</relationshiptype>
<conceptname>
<codesequence>
<codevalue>000555</codevalue>
<codingschemedesignator>LNdemo</codingschemedesignator>
<codemeaning>Recording Observer</codemeaning>

XML

Parser A

Parser B



Display C

Display D

API Boundary

Report of Chest X-Ray (PA and LateralViews)

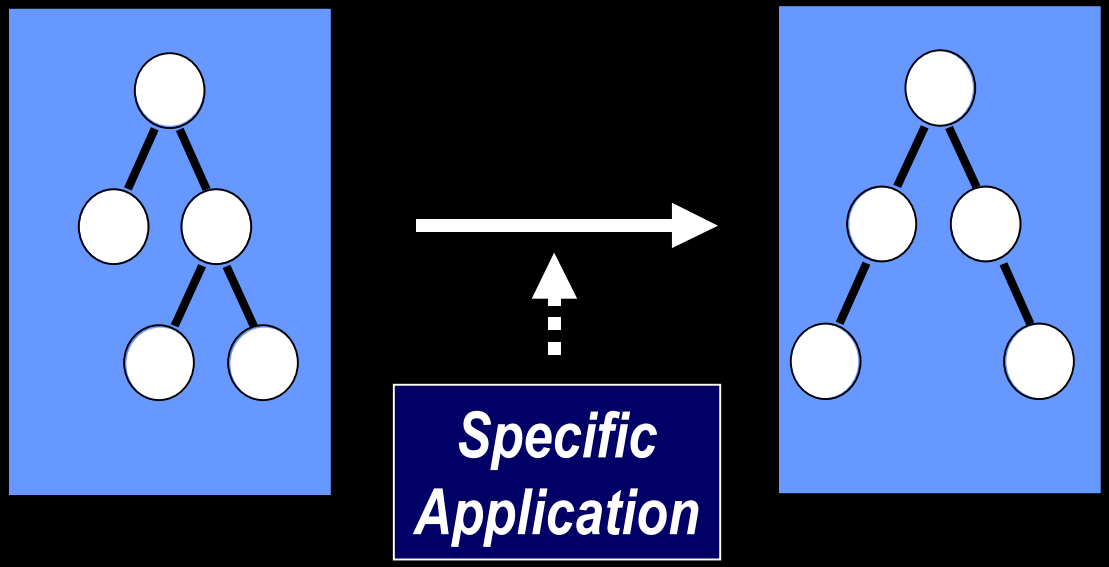
Patient Jane Homer
Study # 123456
Recorded by Dr. John Smith

The finding is a mass measuring 1.3 cm in diameter with an infiltrative margination.

Chest X-Ray
has concept modifier Views=PA and Lateral
Recording Observer=Smith^John^^Dr^
Study Instance UID …=1.2.3.4.5.6.7.100
Patient-Data-Acquisition-Subject=Homer^Jane^^^
Finding=Mass
has properties diameter=1.3 cm
has properties margination=infiltrative (1.4.2)

DICOM SR: Object Model

Trans-coding == Tree Re-writing



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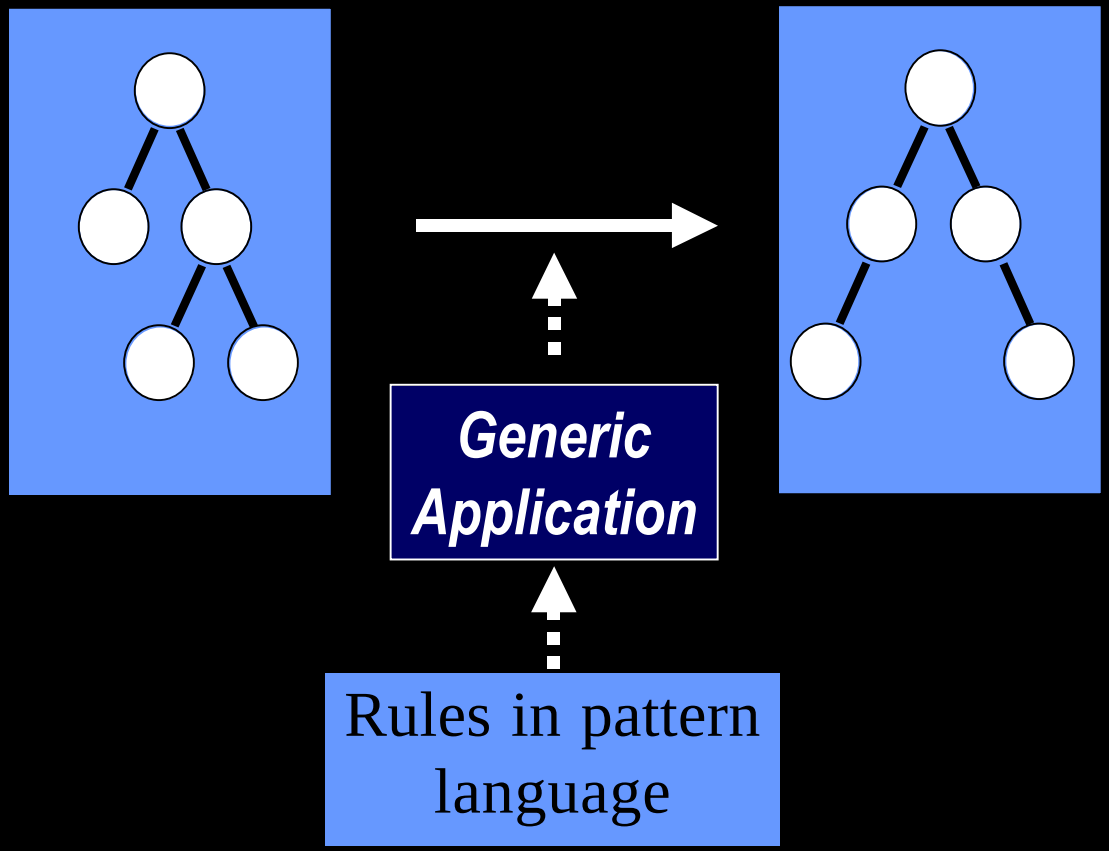
DICOM SR: Object Model

Trans-coding == Tree Re-writing



DICOM SR: Object Model

Representation-independent APIs

- Object model
  - Internal representation of tree
  - Methods to traverse tree
  - Methods to get/set names/values
- Event stream
  - Start and end node “events”
  - Register call-backs or over-ride methods

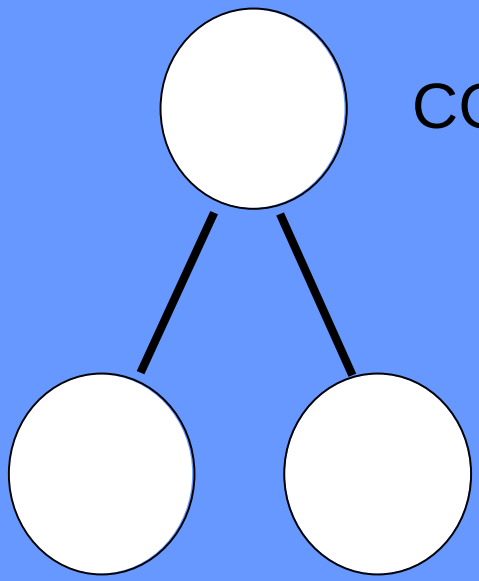
Object Model v. Event Stream

CONTAINER: (,,“Procedure”)

contains TEXT: (,,“Description”)=“PA,lateral”

contains DATE: (,,“Date”)=“20010218”

Object Model v. Event Stream



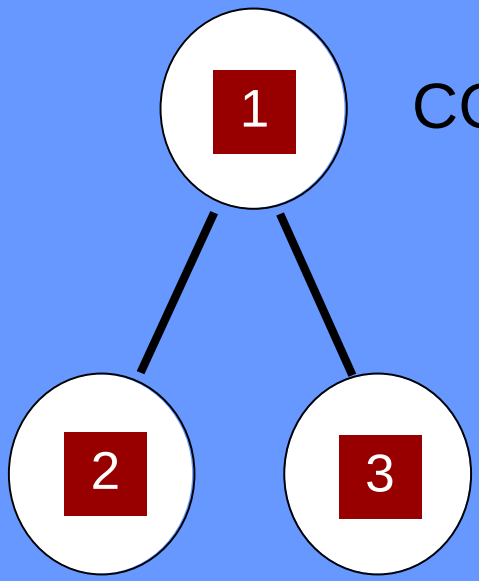
CONTAINER: Procedure

contains

DATE: Date = 20010218

TEXT: Description = PA

Object Model v. Event Stream



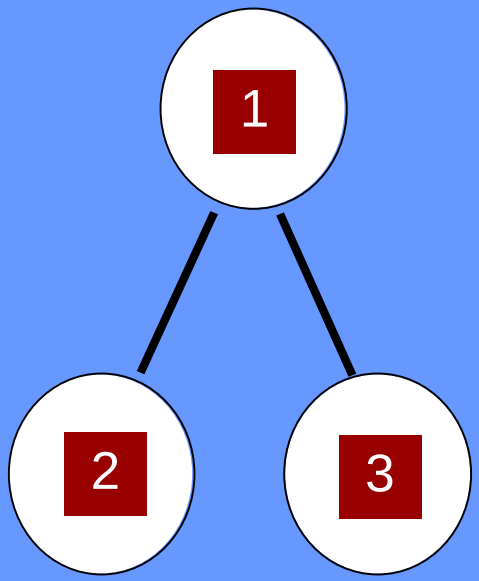
CONTAINER: Procedure

contains

DATE: Date = 20010218

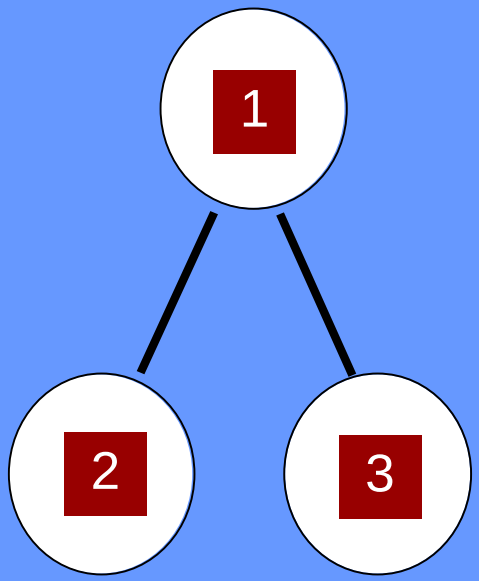
TEXT: Description = PA

Object Model v. Event Stream




```
Node node=Document.getRootNode();
node.getName();
for (node=node.getFirstChild();
      node!=null; node.getNextSibling()) {
          node.getName();
          node.getValue();
}
```

Object Model v. Event Stream




```
startDocument();
  startElement();            // 1:
    getAttribute();          // name=procedure
    startElement();          // 2:
      getAttribute();        // name=description
      getAttribute();        // value=PA
    endElement();            // 2:
    startElement();          // 3:
      …
    endElement();            // 3:
  endElement();              // 1:
endDocument();
```

DICOM SR: Object Model

Which to choose ?

- Object model:
  - May be traversed in different order
  - May be edited in place
  - Document size may be constrained
- Event stream:
  - Not constrained by storage (memory)
  - Faster if traversal order matches need
  - Application may need to preserve state

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DICOM SR: Object Model

Re-using Internet Tools for SR

- W3C Document Object Model (DOM)
- Simple API for XML (SAX) events

- Robust, fast XML parsers
- XSL-T engines

Re-use of XML Tools

- Two choices:
  - literal representation of SR in XML
  - “virtual” XML model or event stream
- Either approach requires actual or virtual XML definition of SR (DTD or Schema)

Literal or Virtual XML DOM

```
Parser parser = new XMLParser()
Document document = parser.getDocument(XMLFile);
```

or

```
Parser parser = new DicomParser()
Document document = parser.getDocument(DicomFile);
```

Re-use of XML Tools

- Two choices:
  - literal representation of SR in XML
  - “virtual” XML model or event stream
- Either approach requires actual or virtual XML definition of SR (DTD or Schema)

Choices of XML Equivalent

```
<ContentItem>
  <ValueType>NUMERIC</ValueType>
  <RelationshipType>HAS PROPERTIES</RelationshipType>
  <Value>13</Value>
  <Units CSD="UCUM"  CV="mm">millimeter</Units>
</ContentItem>
```

```
<ContentItem  VT="NUMERIC" RT="HAS PROPERTIES" V="13"
  U_CSD="UCUM" U_CV="mm" U_M="millimeter"/>
```

```
<item>
<tag G="0040" E="A010" N="RelationshipType" V="HAS PROPERTIES"/>
<tag G="0040" E="A040" N="ValueType" V="NUMERIC"/>
</item>
```

Limitations of XML Tools for SR

- XML and SR are similar but different
- XML:
  - Elements lack “name-value pair” concept
  - “value”: plain characters or nested content
    - alleviate by using attributes of elements
  - Few constraints on PCDATA content
    - alleviate by using Schema rather than DTD
  - No relationships (implicit containment)

DICOM SR: Object Model

Value Types

- TEXT
- CODE
- NUM
- PNAME
- DATE
- TIME
- DATETIME
- CONTAINER
- UIDREF
- COMPOSITE
- IMAGE
- WAVEFORM
- SCOORD
- TCOORD

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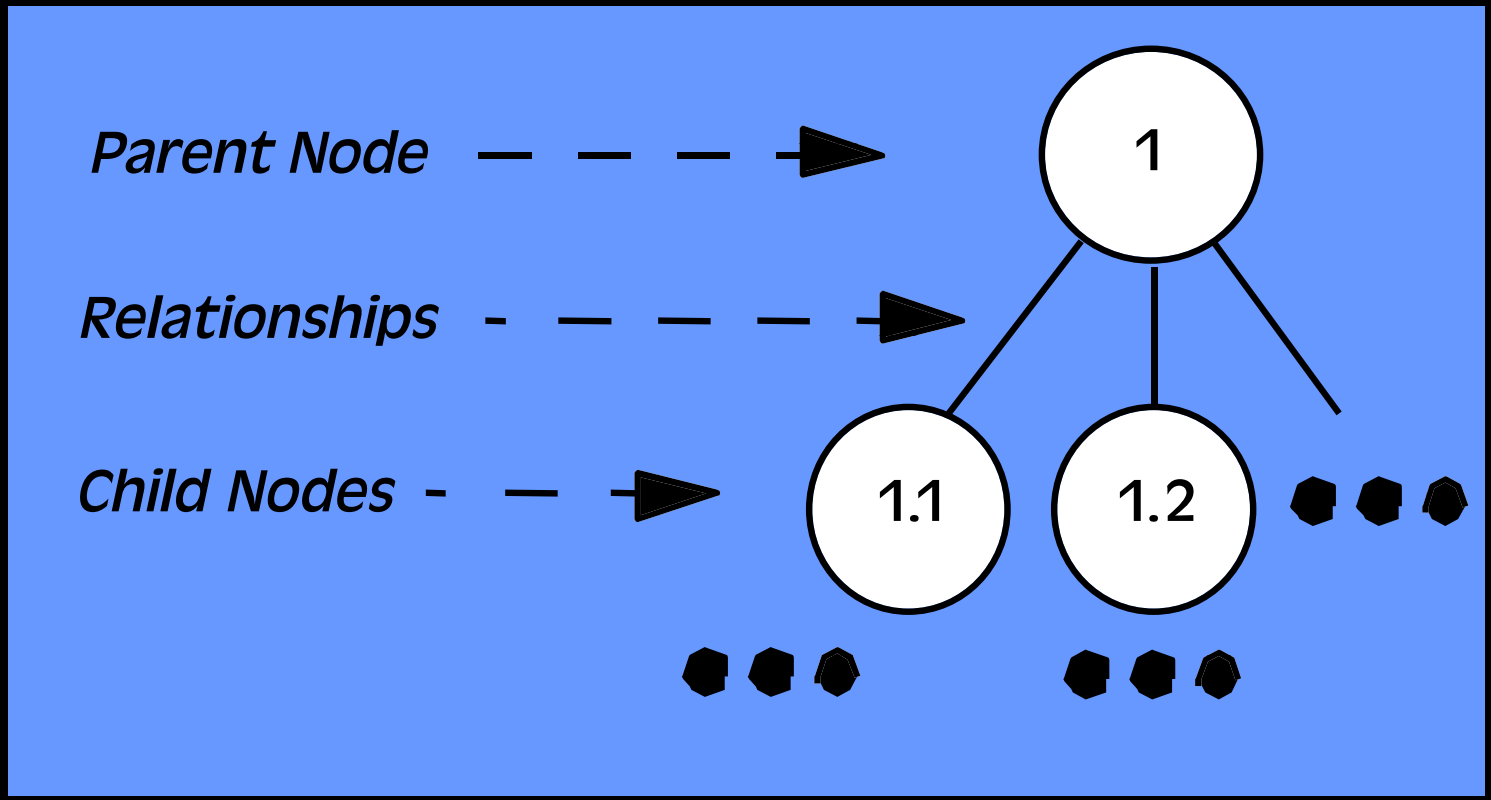
Nodes linked by Relationships



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Relationships

- Contains
- Has Properties
- Inferred From
- Has Observation Context
- Has Acquisition Context
- Has Concept Modifier
- Selected From

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DICOM SR: Object Model

SR Specific Object Model (SR-OM)

- Re-use DOM (or SAX) principles
- Define methods specific to SR
- Simplifies SR-aware application
- Limits re-use of such tools as XSL-T
- Solve by providing automatic SR-OM <-> DOM tools
- Avoids need for virtual XML DTD

SR-OM Classes/Interfaces

- Not just *Node* but:
  - *TextNode*
  - *CodeNode*
  - *ContainerNode*
  - *ImageNode*
  - etc.

SR-OM Node Methods

- Re-use all DOM traversors/iterators:
  - *getChildNode*(), *getNextSibling*(), etc.
- Add accessors for SR-specific content:
  - *getNodeName*()
  - *getNodeType*()
  - *getRelationshipType*()
- More content than #PCDATA
  - Coded entries (names, code values, units)

Conclusions

- Separate domain expertise by API boundaries
- Separate model of information from representation
- Re-use XML tools and lessons

Conclusions

- Three approaches
  - Document Object Model (DOM)
  - Simple API for SAX (SAX)
  - SR-specific versions of above
- Choice depends on
  - Need for interaction with other tools
  - Level of abstraction of SR details