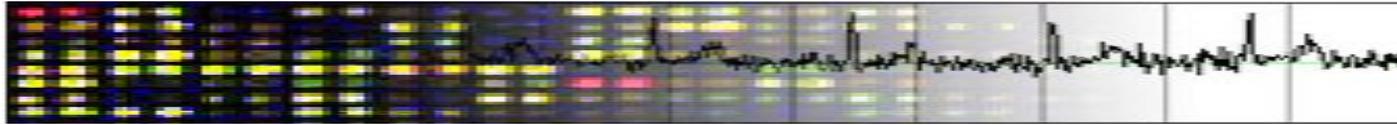


Biomedical Information Technology

2.771J BEH.453J HST.958J Spring 2005

Lecture 8 March 2005

Medical Imaging Information I



Medical Imaging Information I

- *Motivation: who needs it?*
- *Construction of a Information Object Definition (IOD)*
- *The DICOM international standard*
- *Implementation examples*
- *The patient-study-series image hierarchy*

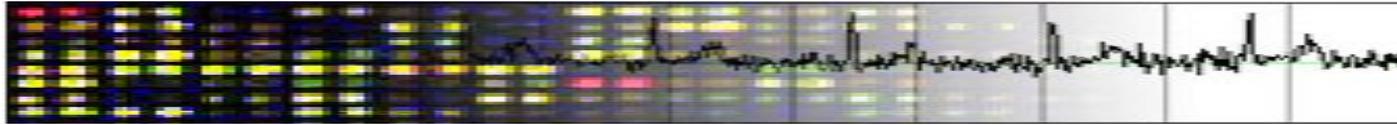


The medical imaging informatics scene

- ❖ Modern medicine depends on advanced diagnostic images
- ❖ Images represent 70% of the potential information in the health care environment
- ❖ The dominant imaging modality is conventional x-rays
- ❖ Images must integrate with radiology, patient records, and billing systems

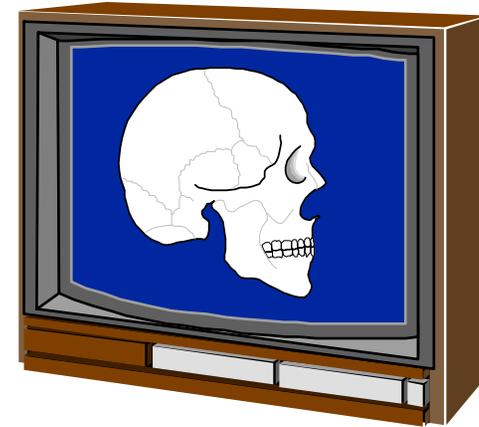
§§§§§§§§ §§§§§§§§ §§§§§§§§

- ❖ What are the solutions?
- ❖ What are the challenges?



Infrastructure: Acquisition

- ❖ Common Modalities:
 - MR, CT, US, Nuclear, CR, XA
- ❖ Emerging Digital Modalities:
 - ECG, Pathology, Lab Tests



- ❖ New vs. Legacy Systems
- ❖ Standard File Formats

- DICOM
- Conversion Routines

| | Size | Bits/ Pixel | Im./ Proc. | Total (MB) |
|-------------|---------|----------------|---------------|---------------|
| CT | 512x512 | 10 | 25 | 8 |
| MR | 256x256 | 16 | 40 | 5 |
| Radiograph | 2Kx2K | 10 | 4 | 20 |
| Ultrasound | 640x480 | to 24 | 30 | 26 |
| Angiography | 1Kx1K | 10 | 15 | 19 |

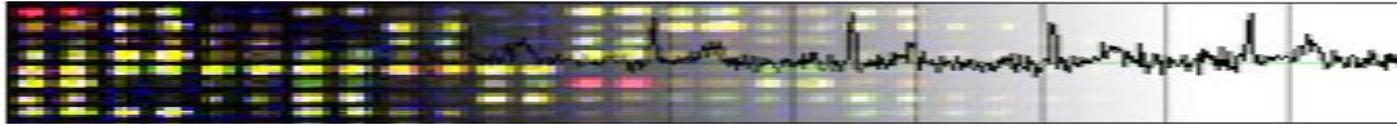
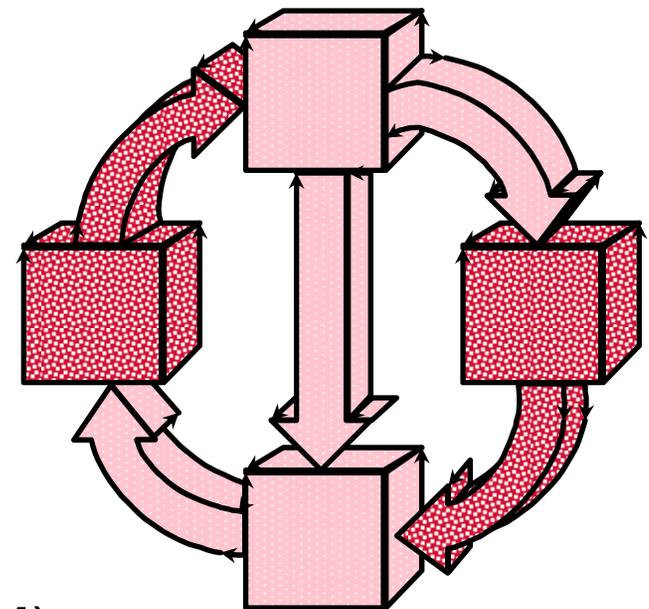
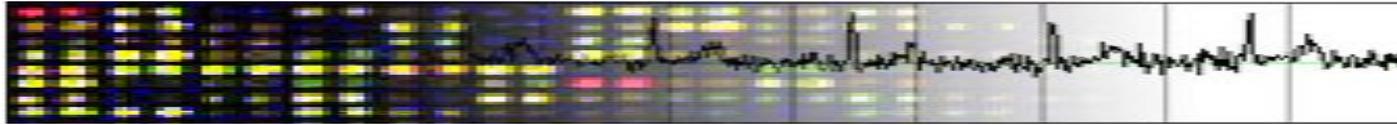


Image File Requirements

- ❖ Extensible Objects
- ❖ Editing and Parsing Utilities
- ❖ Require Standard Display Services
 - X-Windows
 - Windows
 - Defined photometric interpretation
- ❖ Meet Standards for Storage
 - Unix, Windows, Mac
- ❖ Meet Standards for Transmission
- ❖ Must Be Self-Describing (e.g. DICOM)





Medical Images As Objects

❖ Common File Formats

- TIFF, PICT, JPEG

❖ Standards

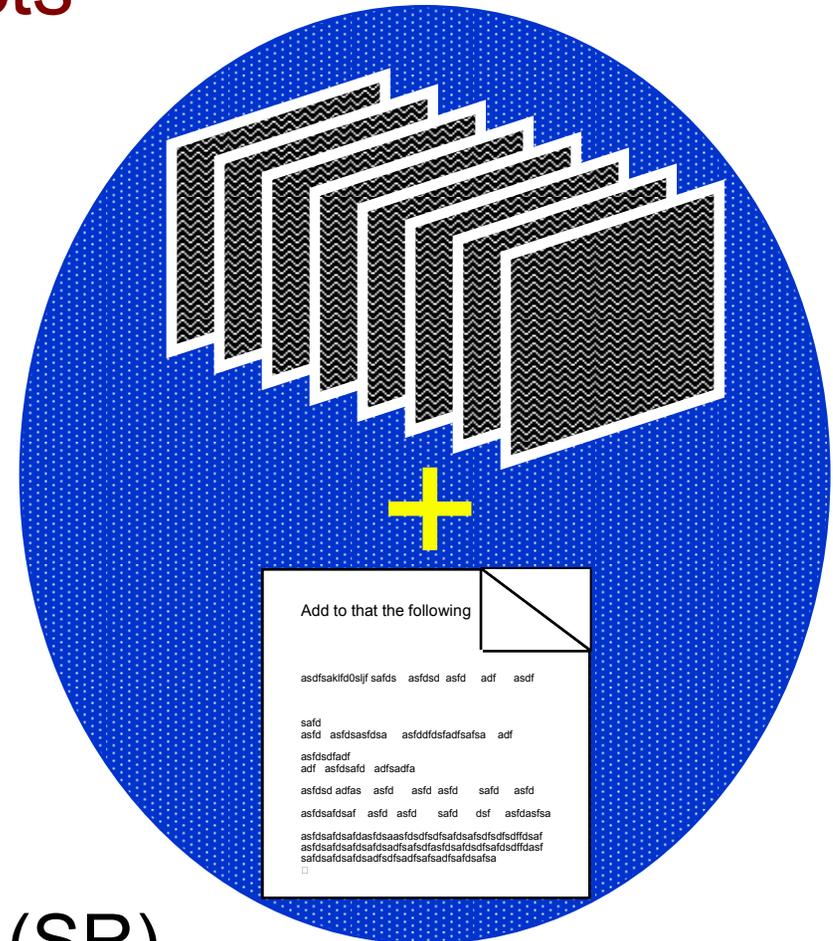
- DICOM
- HL7
- CEN TC251/WG4

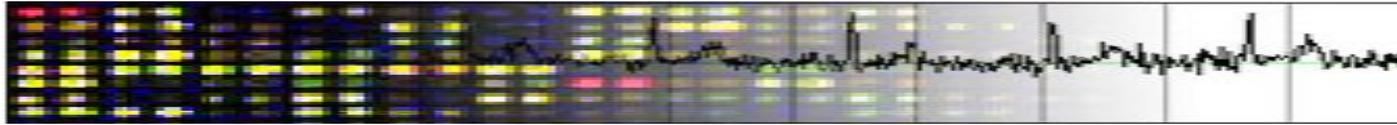
❖ Compound Objects

- Patient data
- Instrument data
- Diagnosis
- Annotations and overlays

❖ Extensibility to new objects (SR)

❖ Define methods and procedures





The DICOM Standard



Scope of DICOM Standard

Digital
Image
Communication in
Medicine

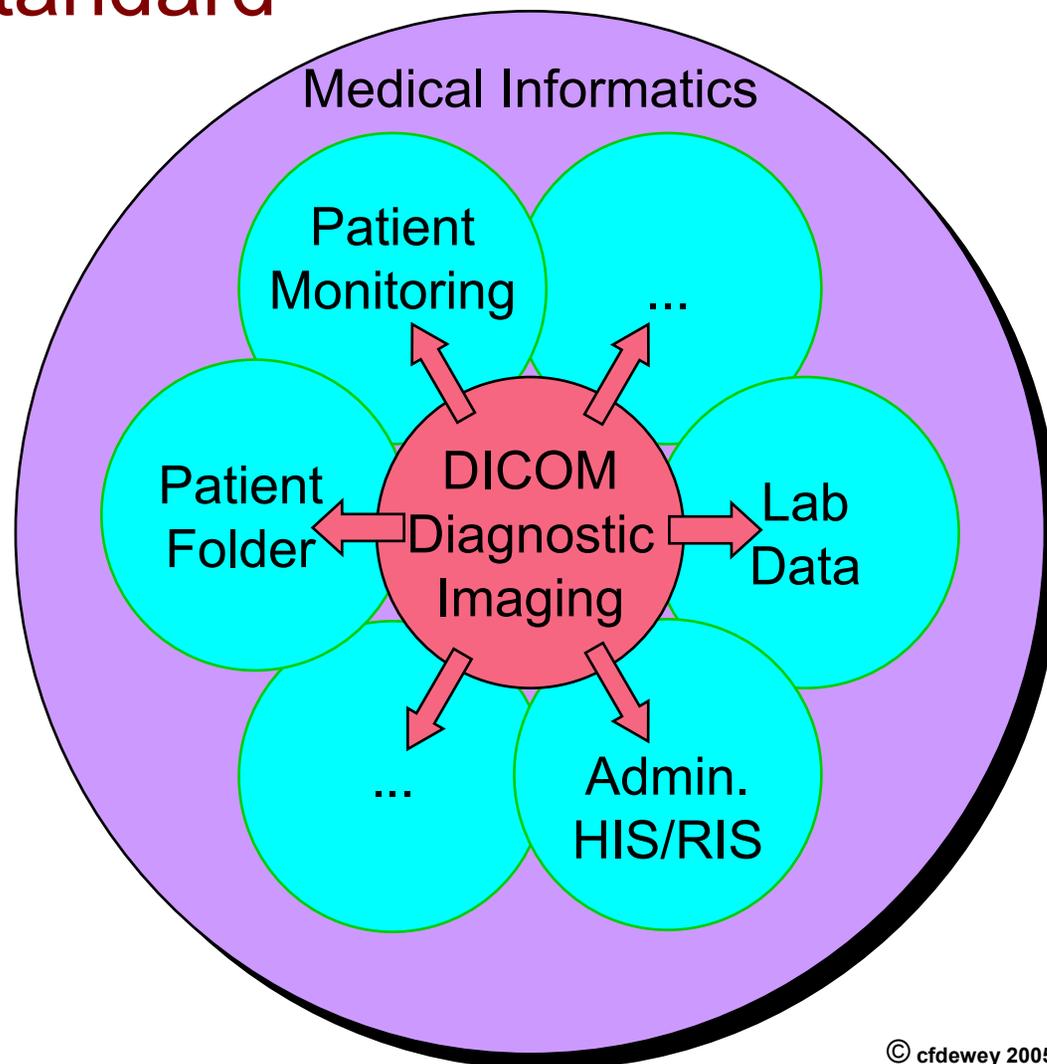
Useful Web Sites

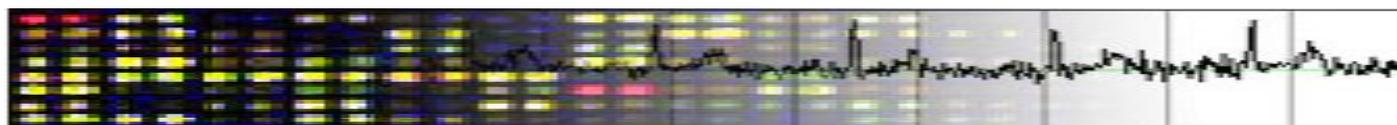
<http://www.nema.org>

<http://www.acr.org>

<http://icmit.mit.edu>

<http://idt.net/~dclunie>





DICOM Chronology

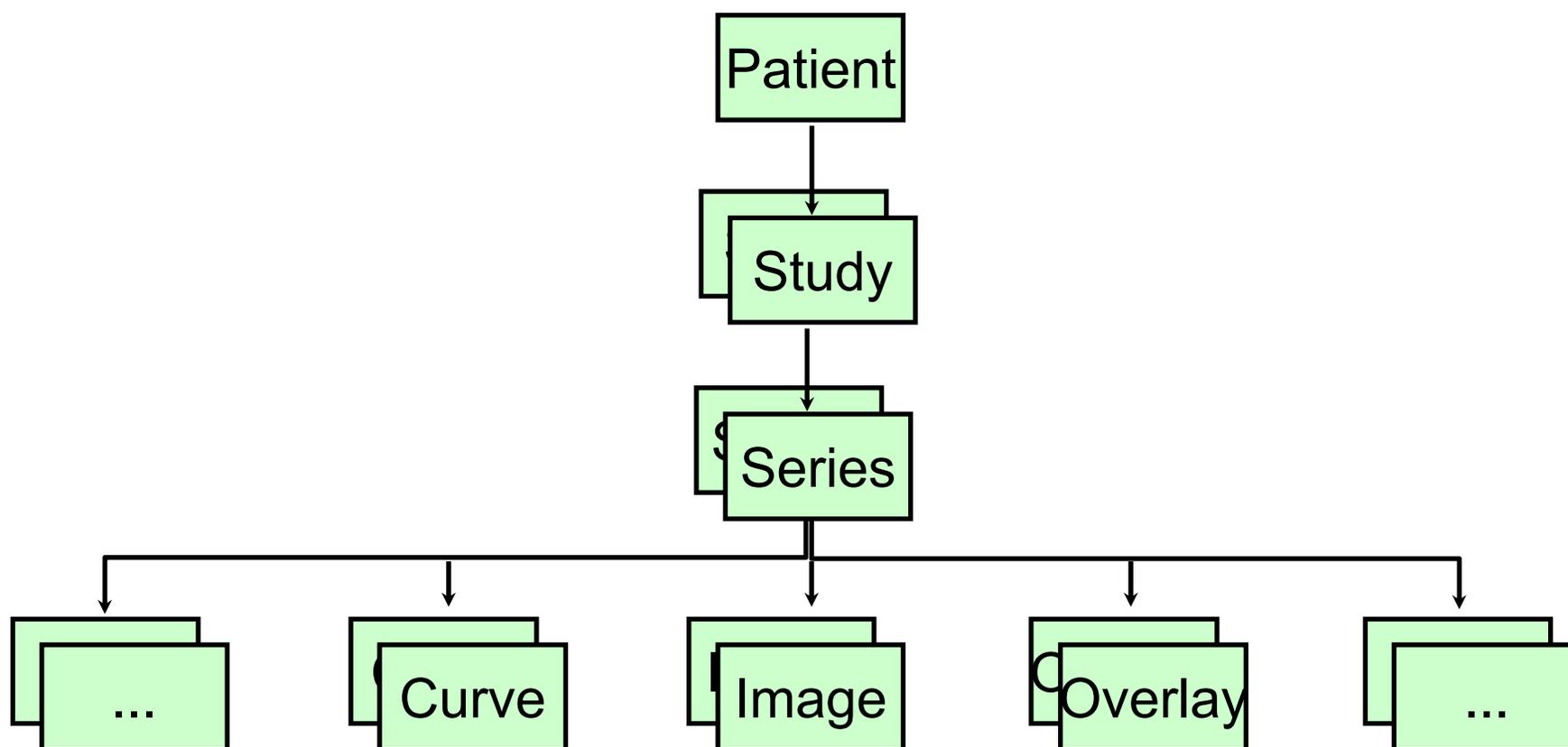
- ❖ ACR-NEMA 2 1986-1990: never flew
- ❖ DICOM-3 Approved Late '93
- ❖ RSNA Network Interoperability:
November '93, November '94
- ❖ Am. Coll. Cardiology XA Demo March '95
- ❖ Ultrasound Media Demo ASE June '95
- ❖ CT, MR, US, XA, NM, Radiographs
- ❖ Pathology, Waveform, Structured Reporting

Note:
DICOM 3 ≡ DICOM

| | | VR | VM |
|---|---|----|-----|
| | a | LO | 1 |
| | | IS | 1 |
| Phases | | IS | 1-n |
| er of Images | | IS | 1 |
| ess | | DS | 1 |
| | | DS | 1 |
| Counts Accumulated | | IS | 1 |
| (0018,0072) Acquisition Termination Condition | | CS | 1 |
| (0018,0072) Effective Time Series Duration | | DS | 1 |
| (0018,0080) Repetition Time | | DS | 1 |
| (0018,0081) Echo Time | | DS | |
| (0018,0082) Inversion Time | | | |
| (0018,0084) Imaging Frequency | | | |
| (0018,0085) Imaged Nucleus | | | |
| (0018,0086) Echo Number | | | |

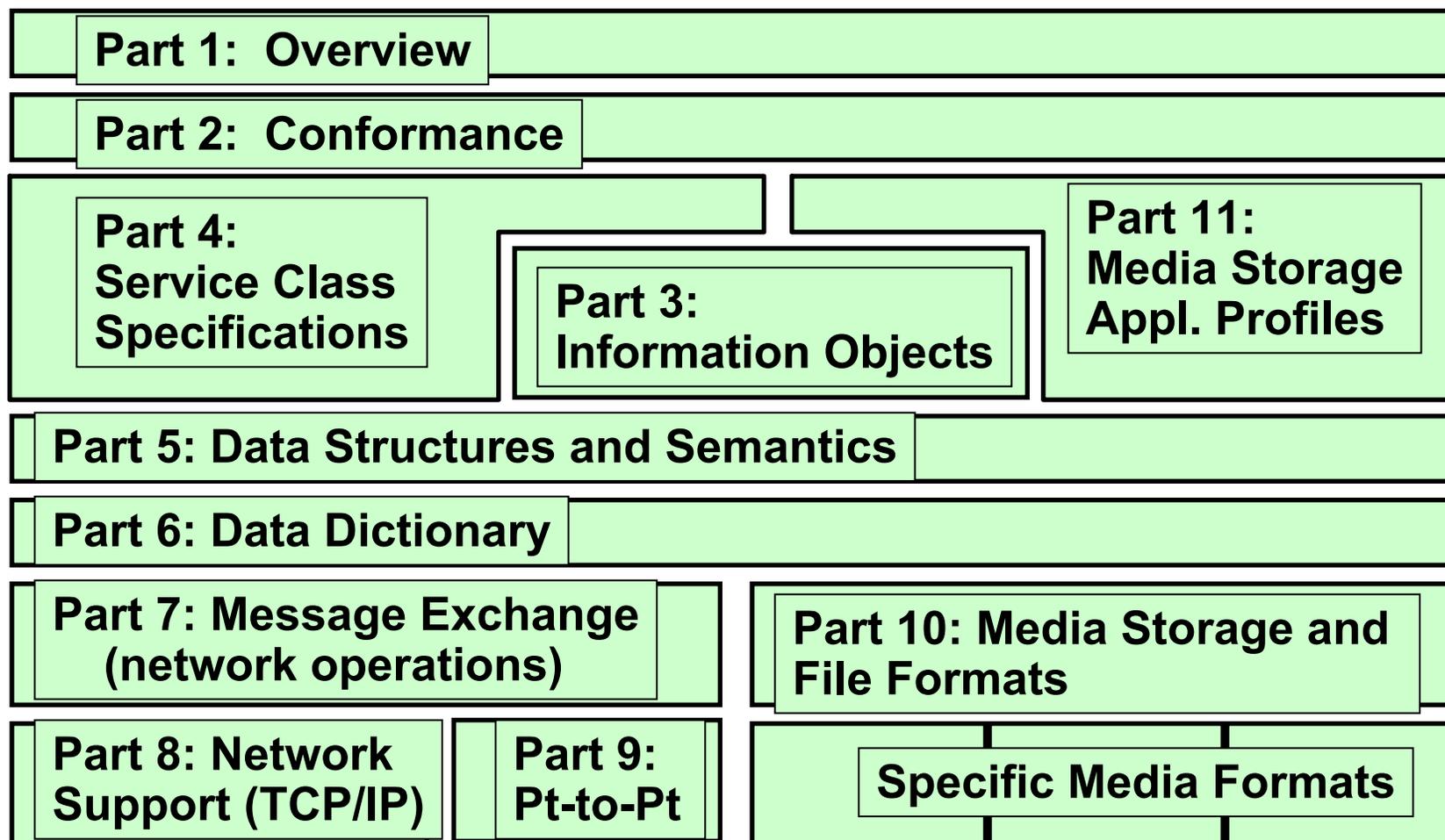


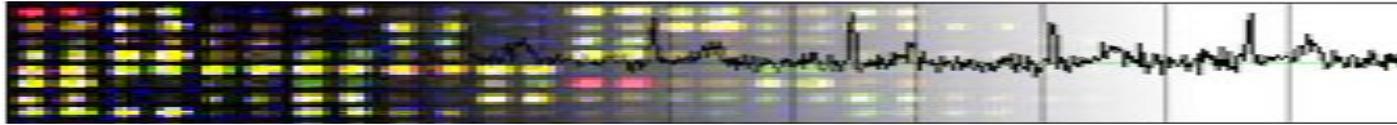
Object model of DICOM standard





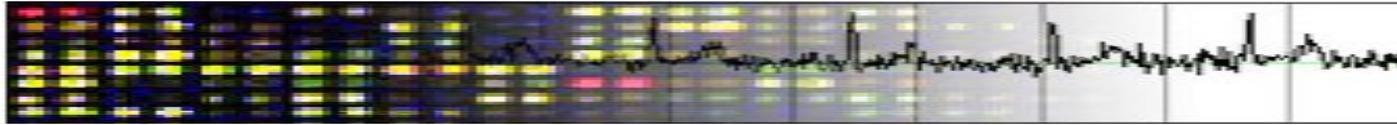
Structure of the DICOM Standard





Status of various DICOM imaging modalities

| Modality | Status | # Attributes |
|------------------------------|----------|--------------|
| CR | Approved | 40 |
| MR | Approved | 75 |
| CT | Approved | 50 |
| US | Approved | 60 |
| XA | Approved | 70 |
| Nuclear | Approved | 60 |
| Visible Light (Pathology) | Approved | 100 |
| Waveform | Approved | 75 |



Implementation Examples



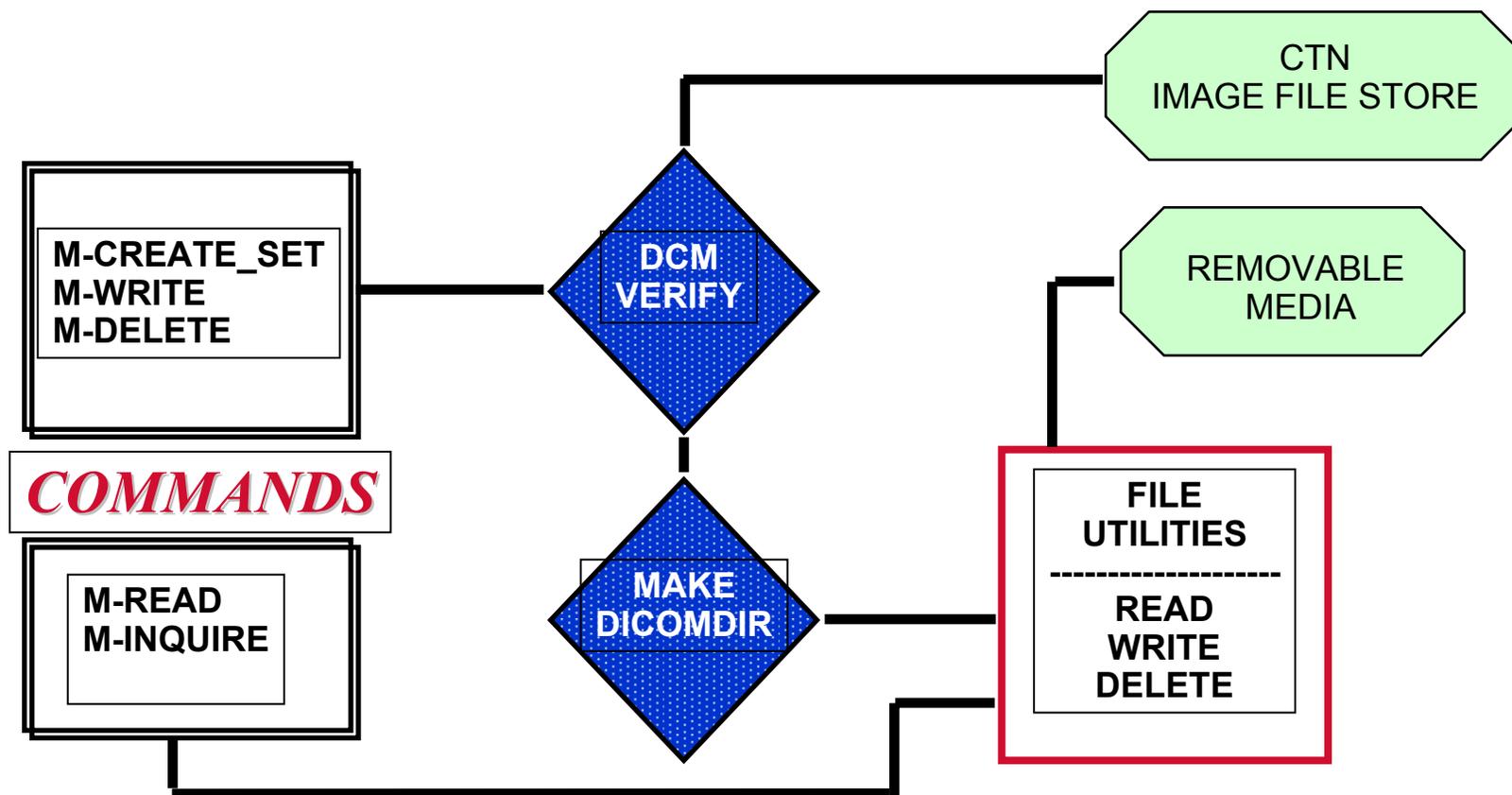
Implementation For Ultrasound

- ❖ ICMIT Chosen to Implement DICOM-3 Conformance Standard for Ultrasound
- ❖ Demonstration at American Society for Echocardiography Meeting in Toronto, June, 1995
- ❖ MO Disks, Floppy Disks, CD-ROM
- ❖ Sponsors:
 - Acuson
 - Hewlett Packard
 - Vingmed
 - Eastman Kodak
 - Toshiba
 - TomTec
 - ATL/Interspec
 - Biosound
- ❖ Further Efforts With Other Image Types:
 - Euro. Cardio. Cong. '95, Am. Coll. Cardiol. '96, Am Nuc. Soc. 96,





ICMIT ASE (ultrasound) server architecture

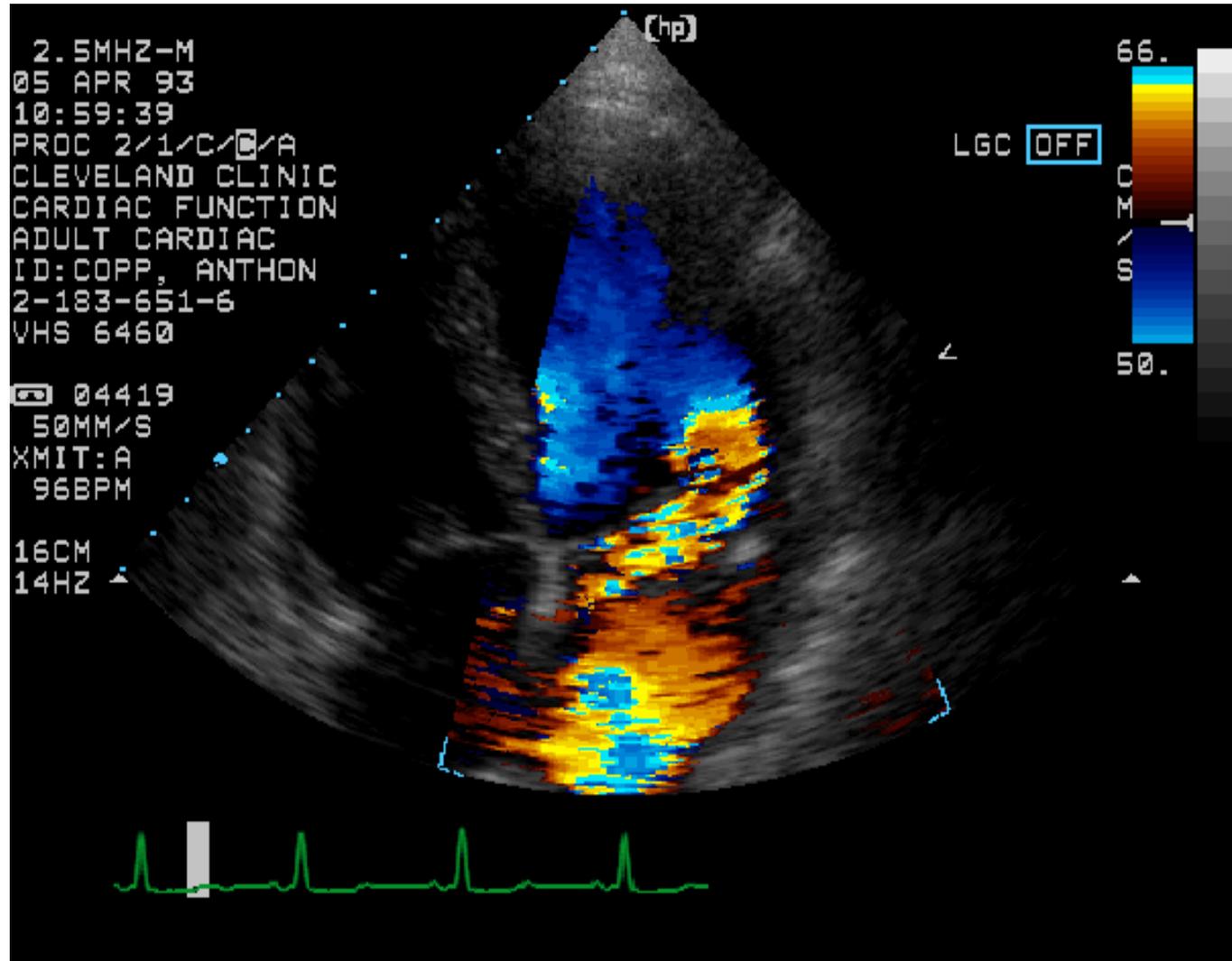


An example ultrasound image from the ASE collection

One picture from an ultrasound film clip stored on a magneto-optical disk and displayable on the computer. Color depicts blood flow velocity.

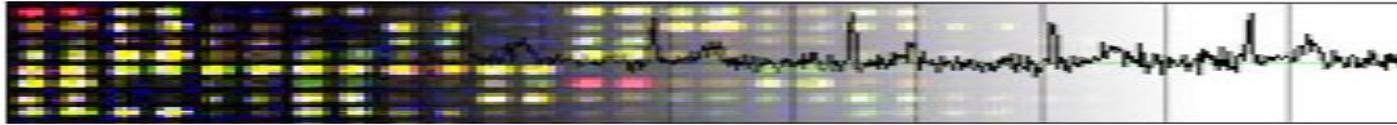
Image stored and displayed using the ICMIT's DICOM software suite.

Original image courtesy of Dr. James D. Thomas, Cleveland Clinic Foundation



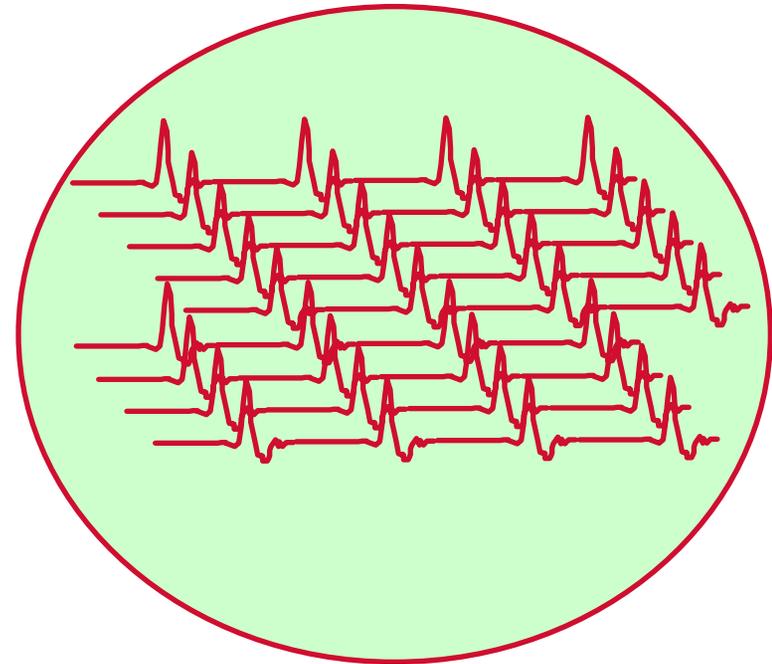
Courtesy of Dr. James Thomas. Used with permission.

© cfdewey 2005

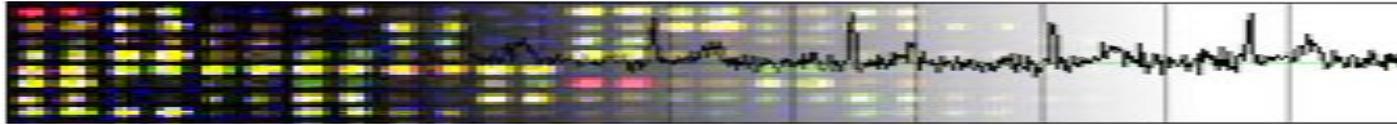


Other image modalities

- ❖ ECG
- ❖ EEG
- ❖ Pathology
- ❖ Endoscopy
- ❖ Pulmonary Sounds
- ❖ Laboratory Images
- ❖ Photographs
- ❖ DNA sequences
- ❖ Chromatography



See ECG “White Paper”



Creating a new modality: ECGs

- ❖ Use Existing DICOM Information Modules

- Patient
- General study

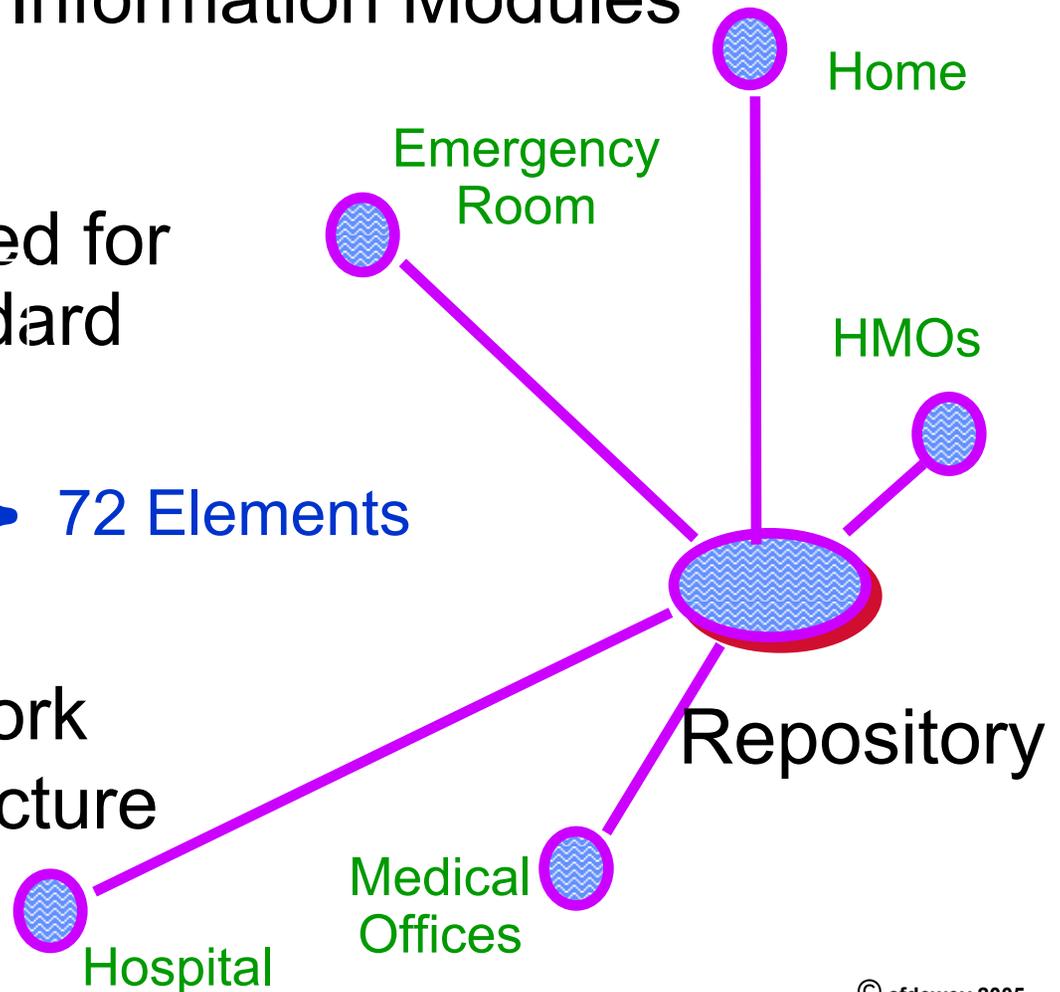
- ❖ New Elements Defined for Proposed ECG Standard

- ECG series
- ECG equipment
- ECG group
- ECG interpretation

} 72 Elements

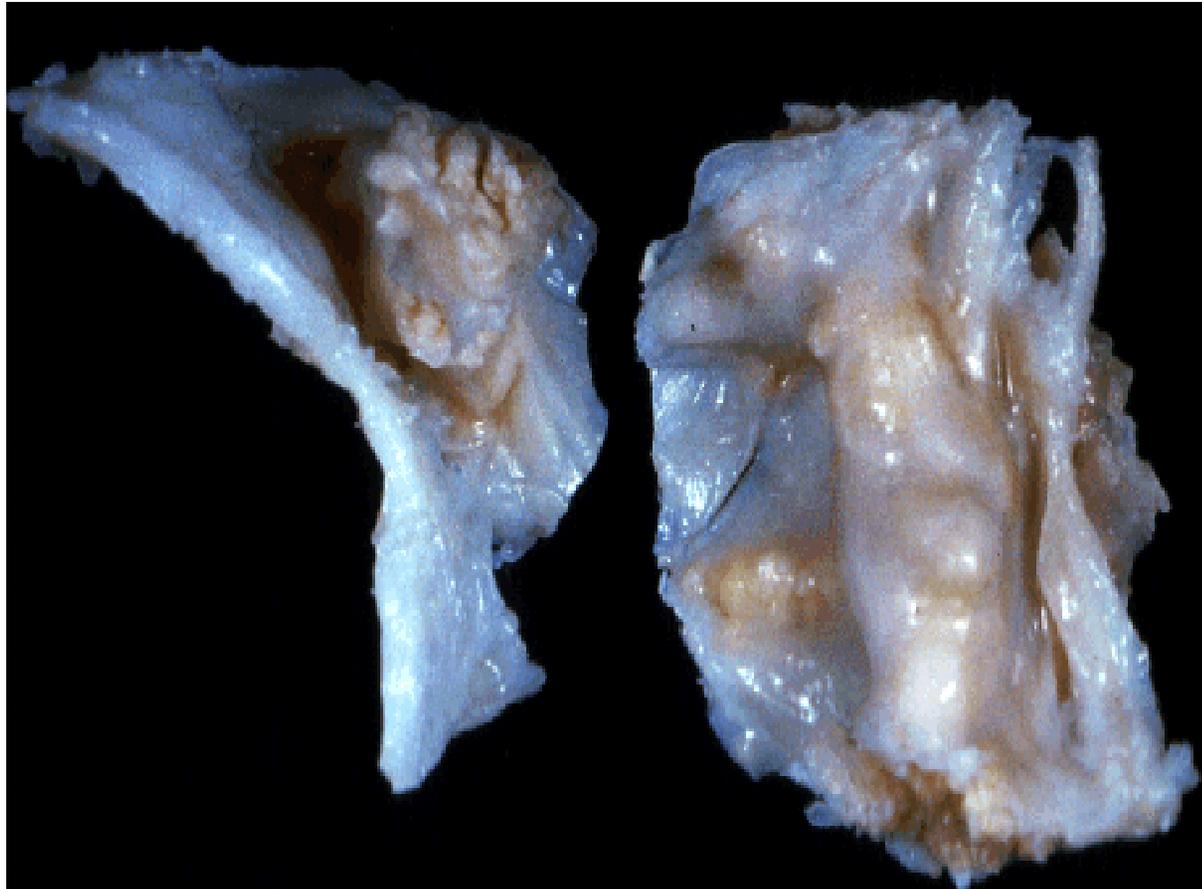
- ❖ Display Over a Network

- ❖ Client-Server Architecture



An Example of a Pathology Image

Human Carotid Bifurcation

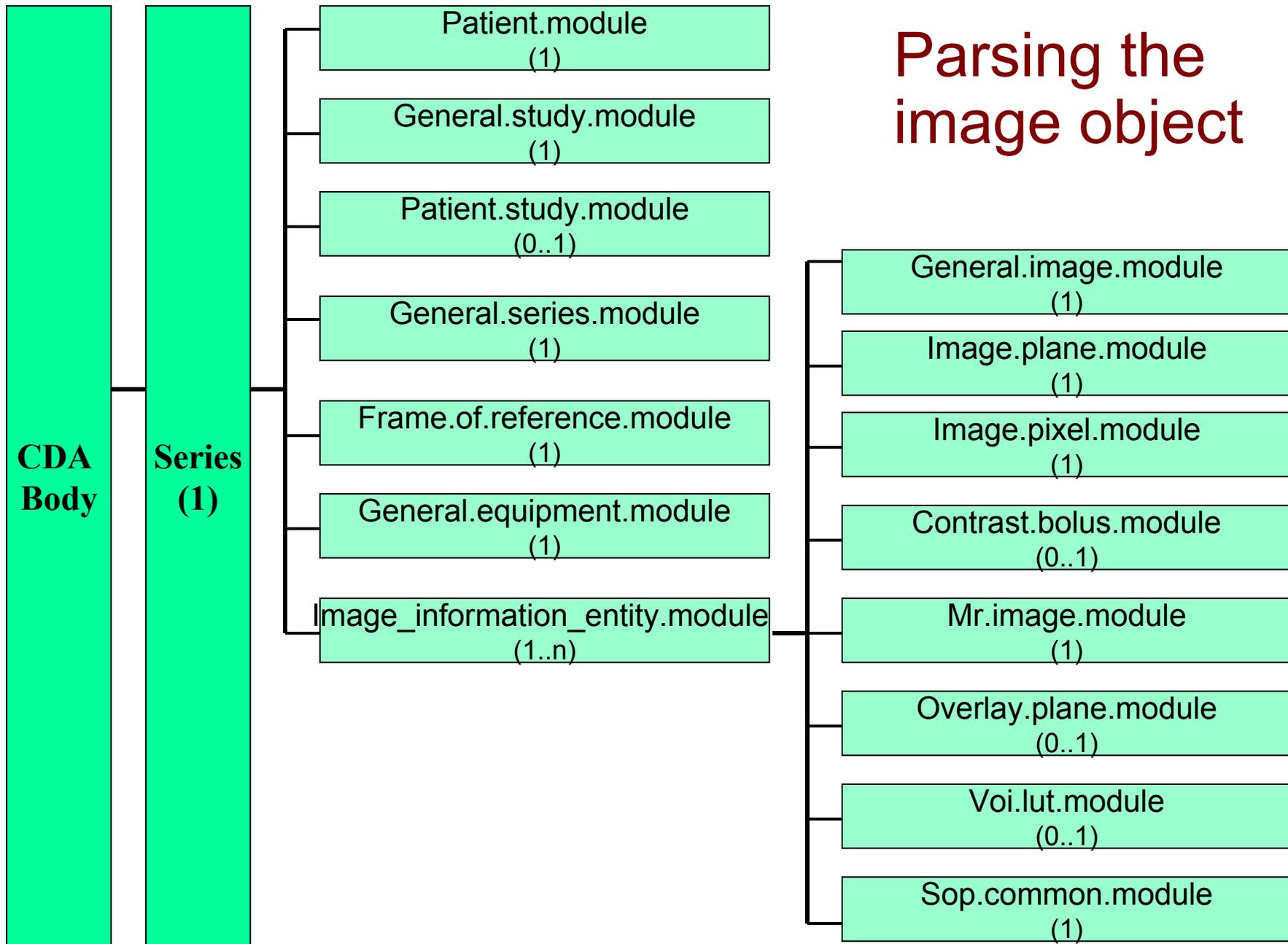


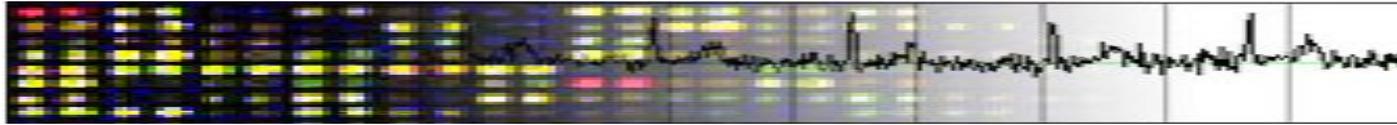
Ref: Dr. John Fallon, Mount Sinai School of Medicine

Courtesy of Dr. John Fallon. Used with permission.

© cfdewey 2005

Parsing the image object





Expressing the image object in XML for use in HL7

```
- <clinical_document_header HL7-NAME="document_service_as_clinical_document_header"  
T="service" RIM-VERSION="0.98">  
- <!-- id, set_id and version_nbr will be automatically generated on document creation -->  
  <id EX="mri example" T="II" EX-T="ST" EX-HL7_NAME="extension" RT-T="OID" RT-  
HL7_NAME="root" AAN-T="ST" AAN-HL7_NAME="assigningAuthorityName" VT-T="IVL_TS" VT-  
HL7_NAME="validTime" PROB-T="REAL" PROB-HL7_NAME="probability" HL7-NAME="id" />  
  <set_id EX="M123" T="II" EX-T="ST" EX-HL7_NAME="extension" RT-T="OID" RT-  
HL7_NAME="root" AAN-T="ST" AAN-HL7_NAME="assigningAuthorityName" VT-T="IVL_TS" VT-  
HL7_NAME="validTime" PROB-T="REAL" PROB-HL7_NAME="probability" HL7-NAME="set_id"  
/>
```

Author: Flora Gilboa IBM Haifa Research Lab

Revision: 0.2 Last update Date : September 5th, 2001