DICOM Overview: Stability and Evolution

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Member, WG6, WG10, WG21
Protocol
• Specifies how two systems exchange information

Many kinds of Systems:
• Modalities, PACS, RIS, Workstations, EMR,…

Many kinds of Information:
• Images, worklists, measurements, surfaces, audit logs,
Routine Clinical Practice

Scheduling Exams

Acquiring Images

Managing Images

Medical Imaging

Processing Images

Distributing Images

Reporting Images

Displaying Images
DICOM stores your images
- **All** kinds of images
- CT, MR, X-Ray, Ultrasound, Angiography, PET, … Ophthalmology, Scanned Documents
- Single & Multiframe; Volumes & Cines; B&W & Color; Original & Processed

DICOM helps manage your Images
- Not just pixels; Significant meta-data
- Patient identification & demographics, the order, eqt, acquisition, workflow context, …
- PACS = database; DICOM = machine readable
- Can query/sort/autoroute/manage
Other DICOM Components

**Store (Imaging) Data**
- fetal growth, cardiac output, tumor size, CAD findings, ECG Waveforms

**Manage (Imaging) Workflow**
- Modality Worklists, Progress updates, Storage Commitment

**Display Images**
- Screen calibration, annotations, layouts, key image flagging
Other DICOM Components

Distribute Images
• Network push/pull, Media Transfer (CD, USB, Bluray…), Email Attachments, Web Protocols

Store Analysis Results
• Registrations, Segmentations, Implant Models

Security
• Audit Trails, De-identification Schemes, Encryption
DICOM is not Static

DICOM first published in 1993

Extended regularly to meet the expanding needs of Medical Imaging:
- Multi-slice CT
- 3D Ultrasound
- Web-based PACS
- USB Memory Sticks
- Clinical Measurements
- Radiation Dose Reporting
- Image Registration & Segmentation
- Computer Aided Detection/Diagnosis
- and Many, Many More . . .
Supplements for major changes
- New object types, new services, new compression schemes
- About 10 / year
- Developed by Working Groups
- Require Work Item approved by DICOM Standards Committee

Change Proposals for minor corrections
- About 100 / year
- Anybody can submit
- Backward Compatibility: Avoid changes that break existing implementations

Consolidated edition published every year (or so)
- Most recently, Late 2011
- Available free at DICOM web site
- Vendors responsible for monitoring final text changes
**Working Groups**

**Modality, clinical domain, or function specific teams, assigned to develop Supplements or Change Proposals**

<table>
<thead>
<tr>
<th>Working Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WG-01</td>
<td>Cardiac and Vascular Information</td>
</tr>
<tr>
<td>WG-02</td>
<td>Projection Radiography/Angiography</td>
</tr>
<tr>
<td>WG-03</td>
<td>Nuclear Medicine</td>
</tr>
<tr>
<td>WG-04</td>
<td>Compression</td>
</tr>
<tr>
<td>WG-05</td>
<td>Exchange Media</td>
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<tr>
<td><strong>WG-06</strong></td>
<td>Base Standard</td>
</tr>
<tr>
<td>WG-07</td>
<td>Radiotherapy</td>
</tr>
<tr>
<td>WG-08</td>
<td>Structured Reporting</td>
</tr>
<tr>
<td>WG-09</td>
<td>Ophthalmology</td>
</tr>
<tr>
<td>WG-10</td>
<td>Strategic Advisory</td>
</tr>
<tr>
<td>WG-11</td>
<td>Display Function Standard</td>
</tr>
<tr>
<td>WG-12</td>
<td>Ultrasound</td>
</tr>
<tr>
<td>WG-13</td>
<td>Visible Light</td>
</tr>
<tr>
<td>WG-14</td>
<td>Security</td>
</tr>
<tr>
<td>WG-15</td>
<td>Digital Mammography and CAD</td>
</tr>
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<td>WG-16</td>
<td>Magnetic Resonance</td>
</tr>
<tr>
<td>WG-17</td>
<td>3D</td>
</tr>
<tr>
<td>WG-18</td>
<td>Clinical Trials and Education</td>
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<td>WG-19</td>
<td>Dermatology</td>
</tr>
<tr>
<td>WG-20</td>
<td>Integration of Imaging and Info Systems</td>
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<tr>
<td>WG-21</td>
<td>Computed Tomography</td>
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<tr>
<td>WG-22</td>
<td>Dentistry</td>
</tr>
<tr>
<td>WG-23</td>
<td>Application Hosting</td>
</tr>
<tr>
<td>WG-24</td>
<td>Surgery</td>
</tr>
<tr>
<td>WG-25</td>
<td>Veterinary Medicine</td>
</tr>
<tr>
<td>WG-26</td>
<td>Pathology</td>
</tr>
<tr>
<td>WG-27</td>
<td>Web Technology for DICOM</td>
</tr>
<tr>
<td>WG-28</td>
<td>Physics</td>
</tr>
</tbody>
</table>
Maintaining Stability

Extension, not “Versioning”

DICOM is a family of SOP Classes

- It’s just “DICOM”; Not DICOM 3.1, 3.2, 3.3, etc.
- Conformance is to SOP Classes; Not to a ‘version’ of the Standard
- New SOP Classes are added; Old SOP Classes don’t change
- Most applications continue to support older SOP Classes when supporting new ones
DICOM SOP Class

Service + Object = Service Object Pair
(Storage + MR Image = MR Image Storage)

SCP – Service Class Provider
• the system that provides the service

SCU – Service Class User
• the system that uses the service
Before two Application Entities (AE) perform a DICOM transaction they first agree:

- what SOP Class they will use (e.g. MR Image Storage)
- who will be the SCU, who will be the SCP
- what the Transfer Syntax will be (e.g. JPEG Lossless)

This process is called Association Negotiation
**DICOM Conformance Statement**

- lists the SOPs supported by a product
- describes product implementation details and behaviors

*(See DICOM Part 2: Conformance)*

- (Association Negotiation for humans…*)
Information Model Stability

- New Services & SOPs conform to existing information/real-world model and associated semantics
- Allows easier implementation
- Facilitates proxying during adoption/transition period
- Like binding to different transport mechanisms
- (Temptation to “improve”)

DICOM Overview: Stability & Evolution
An Image (or other IODs) holds acquired data
A Series may group closely related Images from the same PPS, same protocol & same piece of Equipment
A Study groups all Series for a given Req. Procedure
A Patient may have many studies

Instances are actual data created based on an object definition
DICOM uses Unique Identifiers (UIDs) to identify:
• specific Instances
• specific SOP Classes
• specific Study / Series
• . . . and many other things
Administered and Published by:

- NEMA (National Electrical Manufacturers Association) and its medical imaging division:
- MITA (Medical Imaging Technology Alliance)

Intellectual Property

- DICOM Trademark and Copyright is held by NEMA
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dicom.nema.org

- Download free electronic copies of the Standard
  - All 20 Parts are available in PDF and MS Word format
  - Paper copies are also available for purchase
- Plans and activities are publicly posted
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Thank you for your attention  !
MR Storage SOP Class

Storage Service

+ 

MR Object

Module Module Module

Attribute Attribute Attribute
**DICOM Terms: Attribute**

**DICOM Data Stream** = …00100010Smith^John^^^…

<table>
<thead>
<tr>
<th>Tag</th>
<th>Attribute Name</th>
<th>VR</th>
<th>VM</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0010,0010)</td>
<td>Patient Name</td>
<td>PN</td>
<td>1</td>
<td>Smith^John^^^</td>
</tr>
</tbody>
</table>

*(See DICOM Part 6: Data Dictionary)*

- **Tag**: (Group #, Element #) to identify an attribute/data element
- **Value Representation (VR)**: data type used to encode the value(s)
- **Value Multiplicity (VM)**: how many values can be in the attribute
**DICOM Terms: Module**

**Patient Module**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Name</td>
<td>(0010,0010)</td>
<td>2</td>
<td>Patient’s Full Name</td>
</tr>
<tr>
<td>Patient ID</td>
<td>(0010,0020)</td>
<td>2</td>
<td>Primary hospital identification number or code for the patient</td>
</tr>
<tr>
<td>Issuer of Patient ID</td>
<td>(0010,0021)</td>
<td>3</td>
<td>Identifier of the Assigning Authority that issued the Patient ID</td>
</tr>
</tbody>
</table>

(See DICOM Part 3: Information Object Definitions)

- **Module**: an architectural convenience; a logical group of attributes about a common topic
- **Macro**: purely an editing convenience; a table of attributes that can be easily copied into modules
- **Type**: (1) Required (2) May Be Empty if Unknown (3) Optional (1C or 2C) Conditional
DICOM Terms: Object (IOD)

**Enhanced CT Object**

<table>
<thead>
<tr>
<th>IE</th>
<th>Module</th>
<th>Reference</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient</td>
<td>Patient</td>
<td>C.7.1.1</td>
<td>M</td>
</tr>
<tr>
<td>Equipment</td>
<td>General Equipment</td>
<td>C.7.5.1</td>
<td>M</td>
</tr>
<tr>
<td>Image</td>
<td>General Image</td>
<td>C.7.6.1</td>
<td>M</td>
</tr>
<tr>
<td>Contrast/Bolus</td>
<td></td>
<td>C.7.6.4</td>
<td>C – Required if contrast media was used in this image</td>
</tr>
<tr>
<td>CT Image</td>
<td></td>
<td>C.8.2.1</td>
<td>M</td>
</tr>
</tbody>
</table>

(See DICOM Part 3: Information Object Definitions)

**Information Entity (IE):** a group of modules representing a Real-World object

**Reference:** a Section in Part 3 where it is defined

**Usage:** (M) Mandatory; (C) Conditional; (U) Optional
### DICOM Services

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print</td>
<td>Printing Objects to a DICOM Printer</td>
</tr>
<tr>
<td>Storage</td>
<td>Storing Objects, e.g. to a PACS</td>
</tr>
<tr>
<td>Query/Retrieve</td>
<td>Getting Objects, e.g. from a PACS</td>
</tr>
<tr>
<td>MWM</td>
<td>Getting Scheduled Patients, e.g. from RIS (Modality Worklist Management)</td>
</tr>
<tr>
<td>MPPS</td>
<td>Status (Started, Completed) back to RIS (Modality Performed Procedure Step)</td>
</tr>
</tbody>
</table>

(See DICOM Part 4: Service Class Specifications)