Making it with quality: Tools for DICOM

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With Thanks to David Clunie for “loan” of slides!
Conflict of Interest

- I write and sell a DICOM toolkit
- This talk is not about my toolkit!
- Please stop me if I “stray”!
The Tools you Need

• Learn about DICOM
  – Books, meetings, the standard itself
  – Review other implementations & images
  – Loggers and Analysers

• Implement your application
  – Toolkits

• Test
  – Testing and validation tools
• DICOM is complex
  – There is a lot to:
    • Understand
    • Get wrong
    • Cope with from others
• A good toolkit protects you from many of the above problems
• Almost all developers use a toolkit of some sort
• Toolkits hide details of encoding from programmer
• Typical Toolkit features
  – read/write DICOM “files” and messages
  – access to lists of DICOM attributes
  – convenient access to pixel and other bulk data
  – memory management for large images
  – compressed image support
  – simplify creating/writing “correct” objects
  – implement network services
  – read/write DICOM media (DICOMDIR)
Choice of Toolkits

• Many variables
  – Languages and platforms
  – Level of abstraction
  – Free & Open Source vs. Commercial “black box”
  – Support and expertise available
  – Advanced viewing capabilities – e.g. 3D
  – Performance and robustness
  – Validation

• Updates
  – Is it still actively developed?
  – Does it incorporate recent DICOM additions?
Data Abstraction Level

- Lists of attributes (data elements)
- Create/extract structure (e.g., trees for sequences)
- Create/extract entire objects, modules, macros
- Create/extract abstract models (e.g., in 3D space)
- Support for enhanced multi-frame descriptors
Network Abstraction Level

• High Level
  – “send set of images” (all negotiation automatic)

• Low Level
  – Create list of presentation contexts
  – Add transfer syntaxes
  – Send to remote AET
  – Receive acceptance/rejection
  – Decide which context to use
  – Send data
  – Received response to each
  – Check errors
  – Close
Know what your toolkit does and does not support

- **Display:**
  - Full greyscale pipeline
  - Shutters
  - Masking
  - Sigmoid LUTs
  - Multi-frame extensions
  - PDF/CDA etc.

- **Network**
  - Async operations
  - Out of band messages – C-CANCEL etc.

- **General:**
  - SOP Class specific or neutral?
  - Transfer syntaxes
• Even with a good toolkit, you can still get a lot wrong!
  – Application design
  – Completeness of data objects
  – Internal relationships within objects
  – Relationships between objects and services (e.g. MWL data ➔ images)
• And toolkits can have bugs
Test Tools

- Only DICOM specific aspects here…

- Does it seem to work as expected?
  - Test objects for “consumption” by your system
  - Viewers to visualise the images you make
  - Servers to connect to
  - “Passive” sniffers

- Specific validators
  - Validators for what you produce
  - “Active” network test systems for protocol ± content validation
Image and other composite objects

- Synthetic – generated de novo
- Real – from modalities (de-identified)
- Combination – modified real images
- Niche tests – e.g. character sets and measurements (David Clunie’s)
“See” what your doing

• Viewer to see your images
  – DicomScope
    • http://dicom.offis.de/dscope.php.en
    • Old, but still useful as it faithfully uses the entire greyscale “pipeline”

• Wireshark to see your networking
  – Has evolved into a good DICOM dumper
  – Can actually save DICOM file from packet capture
  – Beware privacy concerns!
Test Servers

- **Public**
  - [www.dicomserver.co.uk](http://www.dicomserver.co.uk)
  - Handles receive/query/retrieve, avoiding configuration issues
    - C-GET
    - C-MOVE assume same port as retrieve command
      - Beware – it contains a lot of junk!
- **Local**
  - within company or hospital or lab
  - tunnel in firewall to DICOM port
Validators

- Validate for compliance with DICOM
  - images and other composite objects in files
  - from media or received/captured from network
  - captured network messages (queries, etc.)
- What to validate
  - compliance with IOD (defined by SOP Class)
  - compliance with template (Structured Reports)
  - correct encoding of attributes
  - compliance with “profiles” (media, IHE)
  - warn of “undesirable” characteristics
Validators

• **DVTK**
  – [http://dvtk.org](http://dvtk.org)
  – Test scenarios and general emulators

• **David Clunie’s test tools**

• Both can to “over call” issues, but it is better to be alert to possibilities and choose to ignore them once you are certain than to be ignorant!
What standard to test against

• What needs to be tested
  – does it “work”?
  – is it “correct”? 

• Compliance with DICOM standard
  – does NOT mean that it will “work”
  – may not be necessary for it to “work”

• For example
  – device may “interoperate” by ignoring non-compliance
  – a compliant device may fail by ignoring a “feature”
Failure to apply Display Shutter to inverted DICOM image
Modality vendor is compliant – sends Display Shutter
PACS vendor is “compliant” – allowed to ignore Display Shutter
PACS vendor promises this “feature” in new version only
   – requires complete PACS server hardware replacement !@#$
Customer “unsatisfied”
IHE and testing

• Original RSNA DICOM testing initiative
  – central test node(s), test tools and plans
• IHE developed “integration profiles”
• IHE “connectathons”
  – standalone testing with tools
  – test scenarios between “actors”
  – tests against reference implementations
  – tests between actual implementations
  – check logs to be sure “work” for right reasons
• Test tools are free and open source
• A connectathon is the best education!
Finding tools

• Google
  – “dicom toolkit”

• Some useful web sites with links
  – http://www.dclunie.com
  – http://www.idoimaging.com

• Forum for dicom discussion
  – news:comp.protocols.dicom
  – http://groups.google.com/group/comp.protocols.dicom/
Finding test images

- Not quite as easy as finding tools
- Google
  - “dicom samples”, “dicom images”
- Some useful web sites with links
  - http://www.dclunie.com
  - http://barre.nom.fr/medical/samples/
- There is no “official” test library
  - ftp://medical.nema.org/MEDICAL/Dicom/DataSets
  - Used to be private, but now appears to be open for all
- NO-ONE seems to have made “minimalist” objects for testing that you don’t rely on optional elements
Conclusions

• Plethora of implementations and tools
  – many are free and open source
  – many are well supported
  – so, do not fear DICOM’s “complexity”

• Testing is important
  – failure to test is inexcusable
  – good testing leads to happy customers

• IHE can help
  – use the profiles, use the tools, participate
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Thank you for your attention!