

# THE DICOM 2013 INTERNATIONAL CONFERENCE & SEMINAR

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## Watch out for that hole! Proper and improper implementations of DICOM

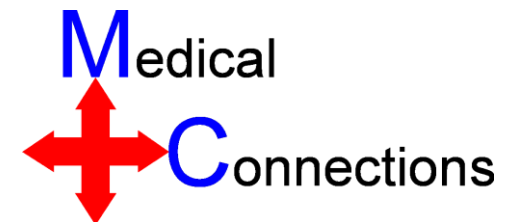
Including “Top 10 common mistakes in  
DICOM”, and how to avoid them

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- **DICOM is all about interoperability**
- **Not everyone follows the rules, but you have to work with them!**
  - Saying “it’s his fault” rarely helps the customer
  - The larger the other supplier, the more true this is
- **So, you need to:**
  - Make sure that what you produce is as accurate as possible
  - Accept “bad data” and “bad behaviour” as much as safely possible
- **This talk is about how to make you a solution rather than a problem in the DICOM world**

# What commonly goes wrong?

- **Simple “Mistakes”**
  - **Misunderstanding the standard**
  - **Coding mistakes - “bugs”**
- **Efficiency disasters**
- **Deliberate incompatibilities/abuses**
  - **“special features”**
  - **Vendor lock-in**
- **Errors and ambiguities in the standard itself**

# Top 10 common mistakes in DICOM

- **Formatting**
  - Basic Low level rules
  - Implicit VR in UN sequences
  - Meta header issues
- **Content**
  - Images with missing/incorrect Character Set
  - Beware that DICOM can be inconsistent
  - Mixing up mandatory/optional
  - Dodgy icons
- **Behaviour**
  - Misunderstanding C-MOVE
  - End of association != end of study
  - Printing is simplistic but difficult

- **Defined mainly in Parts 5 & 10 of DICOM**
- **These are the smallest and easiest to read parts of DICOM – every DICOM developer should read them in full**
- **The easiest errors to identify by simple validators, but people still leave them in production code.**

- **Basic Low level rules**
  - Filenames must conform to CS rules, with upper case, space, \_ and digits only
  - Leading 0s are not permitted in UIDs
- **Sequences labelled “UN” must be Implicit VR**
  - Whatever the surrounding transfer syntax
- **Meta header issues**
  - 0002 group is NOT part of the dataset on the wire
  - Must have a length, to know when to change transfer syntax!

- **Defined mainly in Part 3 of DICOM**
  - Defined via “modules”
  - Different for every SOP class
  - Varying optionalities
- **Can be identified by good validators, but harder than formatting issues, as some relate to “real world” conditions**

- **Missing/incorrect Character Set**
  - If no 0008,0005 then you **ONLY** have ASCII!
- **DICOM can be “unusual”**
  - Rows & Columns are specified as Y\X
  - But 3D coordinates are X\Y\Z
- **Confusion between mandatory & optional elements**
  - Easy to “forget” mandatory elements, but easy to check for them being missing with validators
  - Harder to check for reliance on missing optional ones



# Dodgy Icons

An error class all on its own!



- **Least useful part of DICOM**
- **Causes most grief**
- **Rules:**
  - Always allowed to be uncompressed
  - If outer transfer syntax is compressed, then they may also be compressed, with same transfer syntax
  - Need full DICOM fragment encoding
  - May not appear in private sequences

- **Defined mainly in Part 4 of DICOM**
  - Defined as “Services”
  - Often with “options”
- **Require simulators for proper testing**
- **Even then, there is a huge range of received behaviours to cope with:**
  - Good
  - Bad
  - “unusual”

- **What does the end of an association “mean”**
  - Unless printing, it means nothing
  - It never means “end of study”
- **Printing is simplistic but difficult**
  - Monochrome & Colour are different processes
  - Meta SOP Classes are not always understood
  - DICOM printers are “dumb”
    - No windowing
    - No presentation states etc.

- **Misunderstanding C-MOVE**
  - **It is NOT the same as C-GET – always needs a reverse path**
    - Set up in database
    - Killed by DHCP, firewalls or NAT
  - **Notifications**
    - Interim notifications are **optional**
    - Completion notification is **mandatory** and must not be sent early

# Efficiency disasters (how to make it go slowly!)

- **Unnecessary compression & decompression, especially JPEG 2000**
- **Bad database design – e.g.**
  - on the fly counting of images
  - Reading the images themselves for C-FIND
- **Multiple single associations**
- **6 second reverse DNS lookup on every association!**

# Common “Abuses”

- **Anything from previous list of common errors**
  - If known about, and not fixed
- **Anything from previous list of efficiency disasters**
  - If known about, and not fixed
- **Typical examples of “Pseudo-DICOM”:**
  - Hiding vital information (such as video) in private elements
  - Badly formatted data, only readable by one company’s viewers
  - Sequencing errors – e.g. sending C-MOVE complete message “all sent OK”, before even trying!

# Problems in DICOM itself

- **DICOM is not perfect!**
- **If YOU find that something is ambiguous, then other may do so as well**
- **In the first instance – ASK:**
  - <http://groups.google.com/group/comp.protocols.dicom/>
  - we're all friendly – honest!
  - If it turns out that clarification is needed, then get involved in writing a correction proposal (CP) – they are a vital part of DICOM development!
- **Longer term – get involved, see:**
  - <http://dicomconference.org/contact/participation-in-dicom-activities/>
  - We were all new to this once upon a time!

- **Getting DICOM “right” is not easy, but please try!**
- **Accept that others may send you “rubbish” – consider carefully how to cope with it.**
- **Try to avoid “fitting in” by following other people’s mistakes unless absolutely unavoidable**
- **Help and clarification are always available from friendly experts**



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***Thank you for your attention !***