

THE DICOM 2014 Chengdu Workshop

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

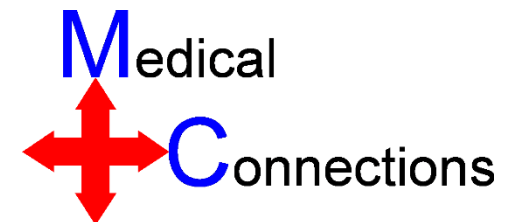
Including “Top 10 common mistakes in DICOM”, and how to avoid them

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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 !