10 "It doesn't do what I want/need/expect…"

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PACS Reality Check

- Why are you surprised ?
- Where are your wants/needs/expectations documented ?
- Did you assume the vendor could read your mind ?
- Did you assume two different vendors connected together could read each others minds ?
- Did you assume all sites have identical needs ?
- Did you think PACS was a commodity ?!@#

Standards Reality Check

- But that's what standards are for, right ?
- Standards address limited use-cases and "levels" of interoperability – balance of flexibility
- Phone "standards" analogy
  - landline works regardless, but caller ID doesn't unless you paid for that option, and the phone matches the service provider
  - smart phone browser, might or might not work with particular page
  - smart phone app, really cool feature, but completely proprietary & tied to vendor and service provider

Assumptions

- You are not in control
- RIS, PACS & modality selection and purchase above your pay grade
- Play the hand you're dealt
- Also applies to outside connections and imported media
- There is a solution to every problem, but you may not be able to afford it
- A problem is a chance for you to do your best

Approach

- Describe the observed behavior
- Describe the expected behavior
- Review the documents (user manuals, conformance statements)
- Instrument the systems (saved DICOM objects, dumps, logs, media, sniffers)
- Seek help (field engineers, Internet forums)
- Change something, workaround, assign blame or accept reality (with greater understanding)

Example - Annotations

- User drawn (also localizer lines)
- Made at modality ? workstation ?
- Saved in PACS (can restore & view)
- Not visible in CD viewer
- Not visible when exported to outside PACS
- All vendors (modality, workstation, CD burner, both PACS) claim 100% DICOM and IHE compliance

Annotations - Behavior

- Observed behavior – annotations stored and reloaded, but not visible on other systems

- Expected behavior – annotations visible on other systems

- Document review – creating system describes annotations stored using Method X – other systems make no mention of annotations or say support Method Y and Z

Annotations – Sending System

- Send images (supposedly with annotations) to 3rd party network storage SCP tool known to accept anything and change nothing (e.g., OFFIS storescp)

- Dump images & other instances looking for evidence of standard or private attributes containing annotations – e.g., overlays, curves, presentation states, SR objects, RT Structure Sets (e.g., dicom3tools dciodvfy)

Annotations – Receiving System

- Send standard test images & other instances to receiving system to observe behavior (e.g., IHE MESA CPI profile test cases)

- Synthesize specific test objects to observe behavior (dccp, ancreate, dcmerge)

- Modify sending systems objects in some way (e.g., Pixelmed DicomCleaner to burn in overlays) and resend to receiving system

Annotations – Seek Help

- Internet forum (e.g., pacsadmin, AuntMinnie, comp.protocols.dicom)
- Q: My PACS vendor A version B saves annotations that no one else can read.
- A: We know, we had version B that used private attributes, but upgrading to version D gave us choice of overlays and presentation states, and here's how to configure them, and the release notes say you can reopen and resave your old ones and they get converted.

Burned In
- Header
- Pixel Data
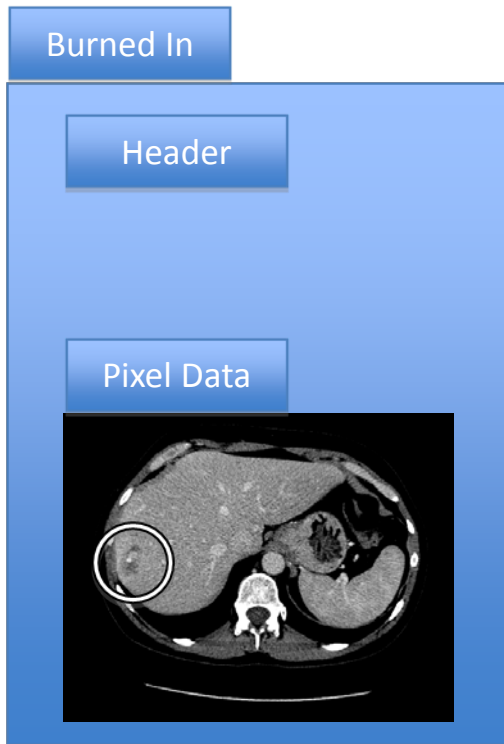
•Cannot be removed
•Covers information

Overlay
- Header
- Pixel Data
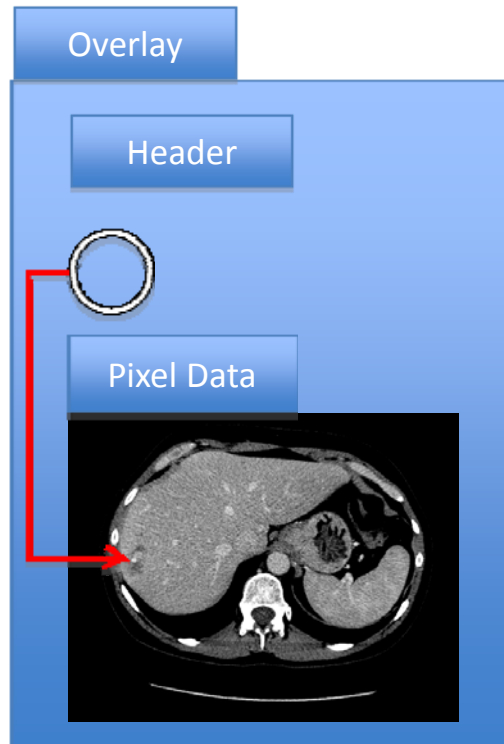
•Can be turned on/off
•Re-save file to add it
•Edit file to hide it

Separate
- Header
- Pixel Data
- Presentation State or SR
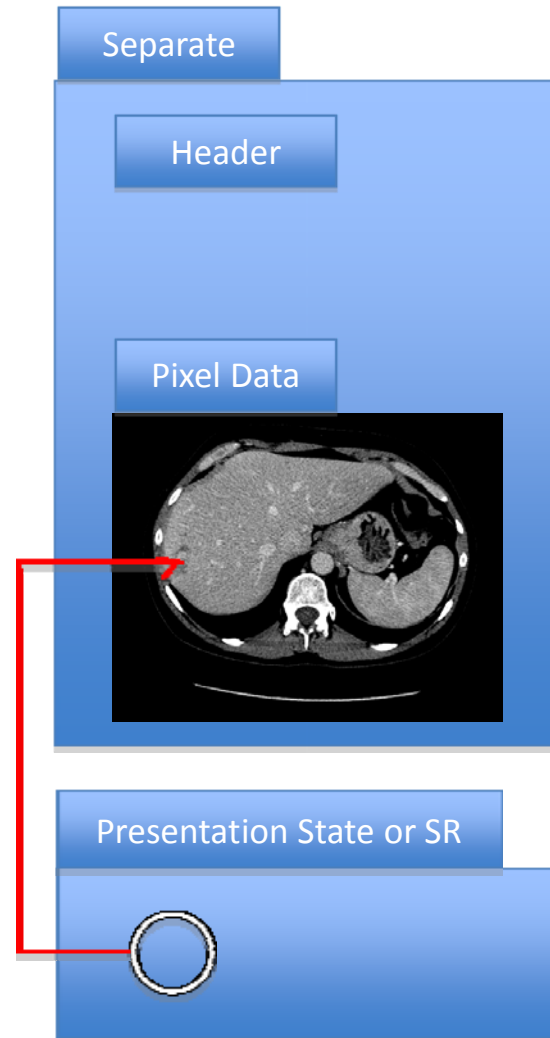
•Can be turned on/off
•Can save and edit independently from image file

DICOM – Pixel Data

- DICOM Image – Burned into Pixel Data
  - Burned into pixel data of the only CT image
    - can't be removed
  - Burned into pixel data of extra image
    - screen save, scrapbook, secondary capture etc.
    - usually separate series from the "original"
  - Recognize by
    - visible in any viewer
    - there are no (60xx,xxxx) attributes in DICOM header

DICOM – Overlay in High Bits

- Overlay in unused high bits of Pixel Data
  - Overlay in high bits of the only CT image
    - may display in some viewers even if no overlay support
  - Overlay in high bits of extra image
    - screen save, scrapbook, secondary capture etc.
    - usually separate series
    - may not display in all viewers
  - Recognize by
    - may not be visible in viewer
    - may not be visible in thumbnail
    - (60xx,0102) Overlay Bit Position is > 0
    - (60xx,3000) Overlay Data is absent

15   12 11   0

DICOM – Overlay Data

- Overlay in separate Overlay Data attribute
  - Overlay in Overlay Data of the only CT image
    - may not display in all viewers
  - Overlay in Overlay Data of extra image
    - screen save, scrapbook, secondary capture etc.
    - usually separate series
    - may not display in all viewers
  - Recognize by
    - may not be visible in viewer
    - may not be visible in thumbnail
    - (60xx,0102) Overlay Bit Position is == 0
    - (60xx,3000) Overlay Data is present

Removing Overlays

- E.g., from the only image supplied
- Tool to check presence of overlays
  - dicom3tools dcckovly
  - lists any (60xx,xxxx) attributes
  - checks high bits for non-zero bits (also dchist)
- Removing nonzero high bits
  - dicom3tools dccp will do it
- Removing overlay attributes (including data)
  - use "-d" argument to dccp for each attribute with hex form for each group, e.g., "-d '(0x6000,0x3000)'"

Presentation States

- Annotations are stored in a separate instance
  - Independent of the image instances
  - No "extra" images per se
  - Presentation State files
    - always in separate series
    - may not display in all viewers
  - Recognize by
    - Modality is "PR"
    - SOP Class is "1.2.840.10008.5.1.4.1.1.11.1" (GSPS)

Intermediate Systems

- Sending system from vendor A stores presentation states – confirmed with storage test tool and validated OK

- Receiving system from vendor B claims support for presentation states – confirmed by import of test objects that display as expected

- Studies sent from vendor A to vendor B on IHE/DICOM compliant CD media don't work

Annotations & CDs

- Expected behavior – CD will contain annotations that will be imported & visible by receiver

- Observed behavior – images visible but not annotations, neither in receiving system, *NOR USING ON-CD VIEWER*

- Document review – unrevealing; DICOM conformance statement for burner claims support for presentation state as SCP without further elaboration

Testing of CD

- Examine content of CD created by sending system

- PDI compliance test tool (IHE/NWU) passes all tests – i.e., "compliant" but doesn't work !

- Dump contents of DICOMDIR (e.g., dicom3tools dcdirdmp) – observer that there are only CT modality series, no PR series

CD Annotations – Seek Help

- Contact vendor A's field engineer – not fruitful
- Observe that CD burning hardware and software actually contain logo of Vendor C (outsourced to third party) and viewer Vendor D
- Contact vendor C's internet help desk – known problem, since the viewer doesn't support presentation states we don't include them; if you configure the presence of the viewer off, they will be included; can't have both until next software release (which may use different vendor's viewer)

CD Annotations - Confirm

- Burn a new CD without the viewer
- Observe presentation states are present with test tool (e.g., dcdirdmp)
- Send a sample to the Vendor B's PACS; annotations show up just fine
- Problem solved … but wait … other CD recipients complain about lack of viewer ☹
- Workaround – buy a different 3rd party burner, and everyone (except finance) is happy

Learn From This Experience

- Annotations are troublesome
- CD tools may not export or import everything
- Somebody somewhere has experienced this before (rarely are you the first)

- Extrapolate
- Anything slightly exotic (not a CT or CR image) may be troublesome

Considering Buying Mammo CAD

- You are given the opportunity to REVIEW & TEST candidates of CAD and Mammo review tool BEFORE purchase

- Proposed workflow is acquisition and CAD at remote site, CD transfer to central site

- We know funky objects are a problem

- We know transfer on media is a problem

Examine Mammo CAD Documents

- CAD Vendor A claims can send any form (DICOM CAD SR, presentation state, modified image with (60xx,3000) overlay data, additional image with burned in)
- CAD Vendor B claims only DICOM CAD SR (which is the one true way, so fair enough)

Examine CD and PACS Documents

- CD burner vendor D documents claim will encode anything even if not supported by viewer, but vendor E will not encode SR objects regardless

- PACS vendor P documents claim will store and regurgitate anything, vendor Q will not accept SR documents

Examine Mammo Viewer Documents

- Mammo package for PACS P won't handle SR documents or presentation states or overlays in images

- Mammo 3rd party workstation X will handle and display CAD in SR, presentation states and handles overlays in images

Mammo – What might work ?

- CAD A or B, CD burner D, PACS P and workstation X would work, and use the DICOM & IHE preferred SR CAD object (but the PACS P Mammo package would not work)

- CAD A, CD burner D or E, PACS P or Q, and mammo viewer P or X would work ONLY if CAD A is configured to send additional image with burned in marks (lame user experience)

- Theoretically … TEST BEFORE YOU BUY

- You want to debug/fix this in the field ?

Nirvana …

- Write everything, accept everything, support everything
- Buy devices that are flexible and configurable (but beware configuring yourself into a non-standard corner – will kill you during migration)
- Niche and specialty vendors use this flexibility to advantage to differentiate themselves
- Large vendors tend to adopt "my way or the highway" attitude
- If given a choice, choose the "IHE way"
- CD burning and mammography are classic examples

Finally …

- Exemplified were high level issues – mostly at the SOP Class or major feature level
- Many more subtle issues …
  - multiple window values and LUTs
  - display shutters, background padding, inversion
  - annotation of demographics/technique missing
  - 3D and 4D dataset and series partitioning, timing
  - …
- The more advanced the feature, the less likely it is to work between vendors
  - whether modality->PACS, or PACS->PACS