71st Annual Scientific Congress of JSRT 2015, Yokohama

DICOM Encoding of Dose Information:
Standards, Tools and Practicalities

David Clunie (dclunie@dclunie.com)
PixelMed Publishing

Background & Disclosures

- Owner, PixelMed Publishing, LLC
- Radiologist
- Independent Consultant
- Editor of DICOM Standard
- Formerly co-chair DICOM Standards Committee
- Formerly co-chair IHE Radiology Technical Committee

DICOM Dose Encoding Learning Objectives

- Goal of DICOM encoding (machine output)
- Radiation Dose Structured Report (RDSR)
- Modalities supported (CT, Projection XR, NM/PET)
- Obsolete mechanisms (image attributes, MPPS)
- Legacy device support – OCR of “dose screens”
- Workflow: IHE Radiation Exposure Monitoring (REM)
- Registry submission issues
- De-identification (DICOM standard profile/options)

Abbreviations

- AAPM – American Association of Physicists in Medicine
- ACR – American College of Radiology
- ADT – Admission, Discharge, Transfer
- CD – Compact Disc
- CID – Context Group ID (Value Set)
- CP – Correction Proposal
- CT – Computed Tomography
- CTDIvol – CT Dose Index - volume
- CR – Computed Radiography
- DAP – Dose Area Product
- DCID – Defined Context Group ID
- DCM – DICOM Controlled Terminology
- DICOM – Digital Imaging and Communications in Medicine
- DIR – Dose Index Registry (ACR)
- DLP – Dose Length Product
- DOB – Date of Birth (Patient)
- DSA – Digital Subtraction Angiography
- DX – Digital X-Ray
- EV – Enumerated Value
- FTP – File Transfer Protocol
- HL7 – Health Level Seven
- HTTP – Hypertext Transfer Protocol
- IEC – International Electrotechnical Commission
- IHE – Integrating the Healthcare Enterprise
- IM/IA – Image Manager/Image Archive (IHE)
- MPPS – Modality Performed Procedure Step
- MPR – Multiplanar Reconstruction
- MWL – Modality Worklist
- NEMA – National Electrical Manufacturers Association
- NM – Nuclear Medicine
- OCR – Optical Character Recognition
- PACS – Picture Archiving and Communications System
- PET – Positron Emission Tomography
- Q/R – Query/Retrieve
- RDSR – Radiation Dose Structured Report
- REM – Radiation Exposure Monitoring (IHE Profile)
- RIS – Radiology Information System
- RRDSR – Radiopharmaceutical Radiation Dose Structured Report
- SFTP – Secure File Transfer Protocol
- SNOMED – Systematized Nomenclature of Medicine
- SOAP – Simple Object Access Protocol
- SR – Structured Report
- SRT – SNOMED Reference Terminology
- SSDE – Size-Specific Dose Estimates
- STOW – Store Over the Web (DICOM)
- TG – Task Group
- TRIAD – Transfer of Images and Data
- UCUM – Unified Code for Units of Measure
- UID – Unique Identifier
- WG – Working Group
- XDM – Cross-Enterprise Document Media Interchange (IHE Profile)
- XDR – Cross-Enterprise Document Reliable Interchange (IHE Profile)
- XDS – Cross-Enterprise Document Sharing (IHE Profile)
- XR – X-Ray

What is our motivation?

- Assuring minimal dose necessary

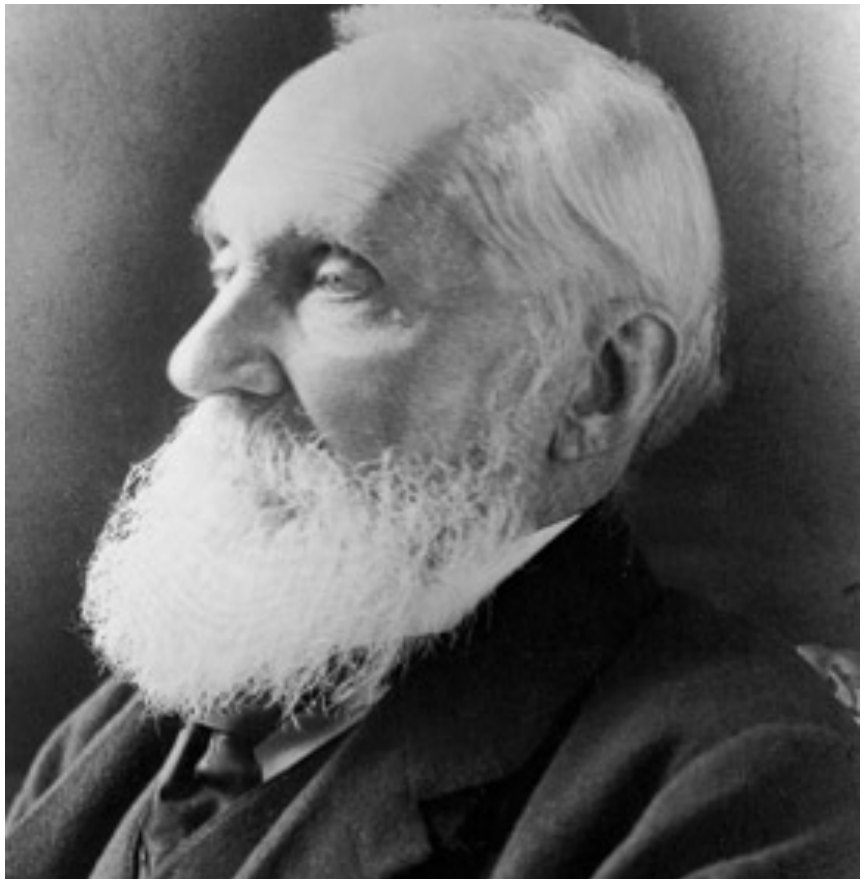
- Reducing operator error
- Reducing inappropriate use of imaging
- Improving protocols
- Improving low-dose technology

- Improving surveillance (locally and nationally)
- Greater regulation and reporting
- Better knowledge base

“If you can not measure it, you can not improve it.”

Lord Kelvin (William Thomson 1824-1907)

1st President of IEC (International Electrotechnical Commission)



What could we encode?

- What would be absorbed by a phantom
  - CTDIvol (mGy)
  - DLP (mGy.cm)
- Biological effect of what was absorbed
  - Organ Doses
  - Effective Dose
- Additional risk to patient
  - Lifetime Attributable Risk (of cancer)

Encoding priority for DICOM is the output of the machine

- What would be absorbed by a phantom
  - CTDIvol (mGy)
  - DLP (mGy.cm)
- Biological effect of what was absorbed
  - Organ Dose
  - Effective Dose
- Additional risk to patient
  - Lifetime Attributable Risk (of cancer)

Phantom versus Patient

- Record what the machine output
  - CTDIvol and DLP describe the output of the scanner as if absorbed by a phantom, not measured in the actual patient
- Extrapolation to real patients
  - requires patient size information
  - impact on organs (tissue weighting factors)
  - assumes knowledge of effect on risk

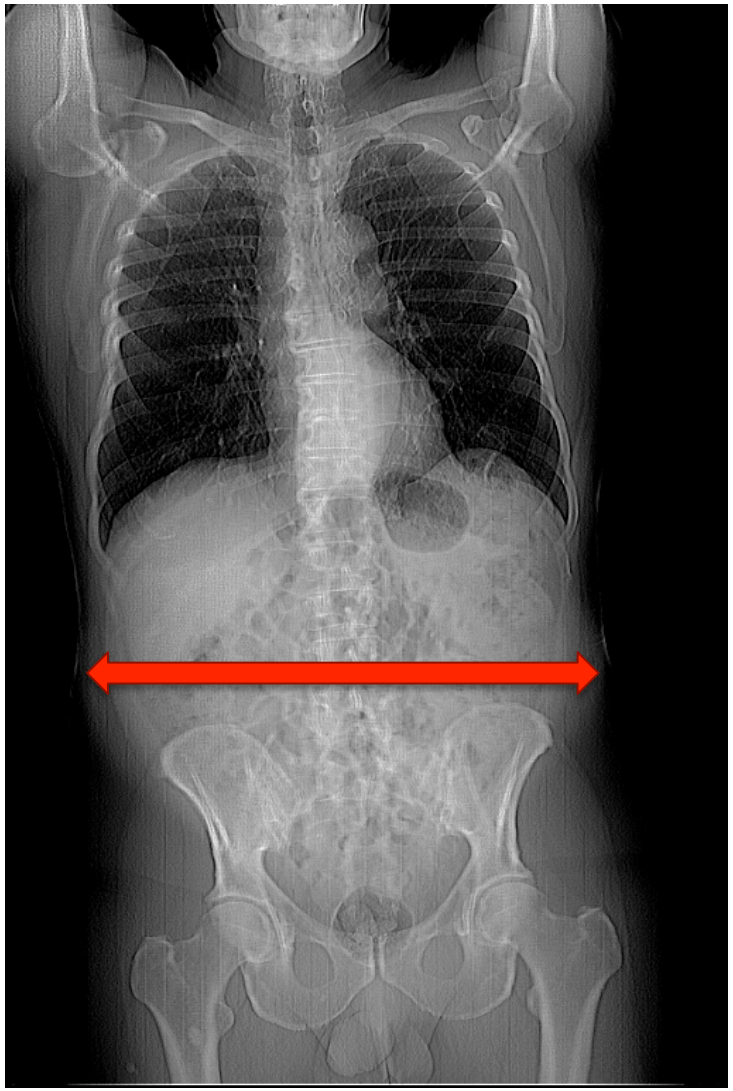
Additional priority for DICOM is the age/size of the patient

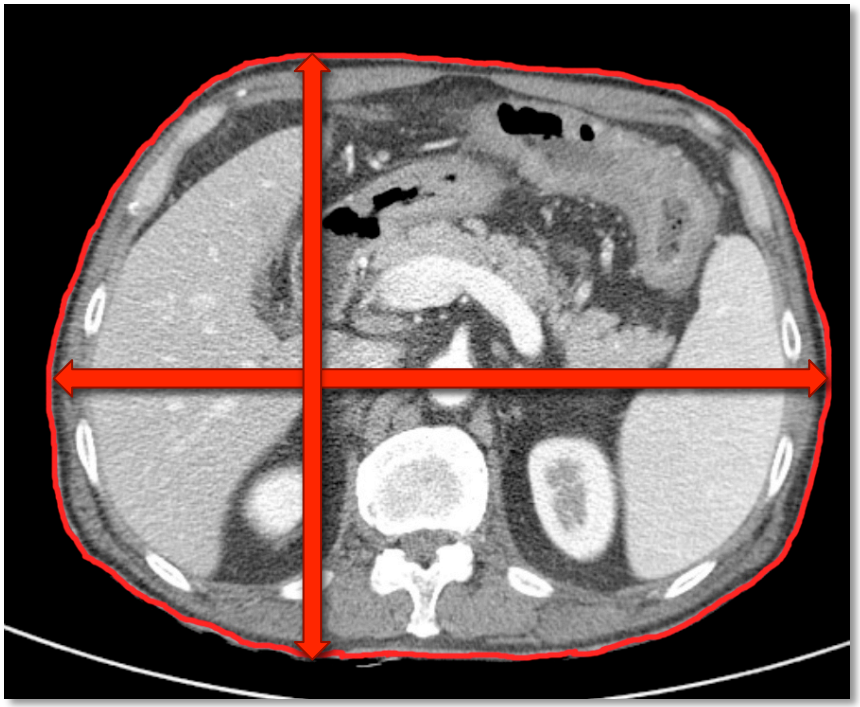
- Record what the machine output
  - CTDIvol and DLP describe the output of the scanner as if absorbed by a phantom, not measured in the actual patient
- Extrapolation to real patients
  - requires patient size information
  - impact on organs (tissue weighting factors)
  - assumes knowledge of effect on risk

Record what we can

- Easy to record
  - per acquisition CTDIvol and DLP
  - total DLP for entire procedure
- Can be recorded
  - *standard* code/term for procedure type
  - *standard* code/term for anatomy
  - surrogates for patient size – age, height, weight, sex
- Harder to record
  - actual measures of patient size (localizer image?)
  - actual organs exposed and extent (segment images?)

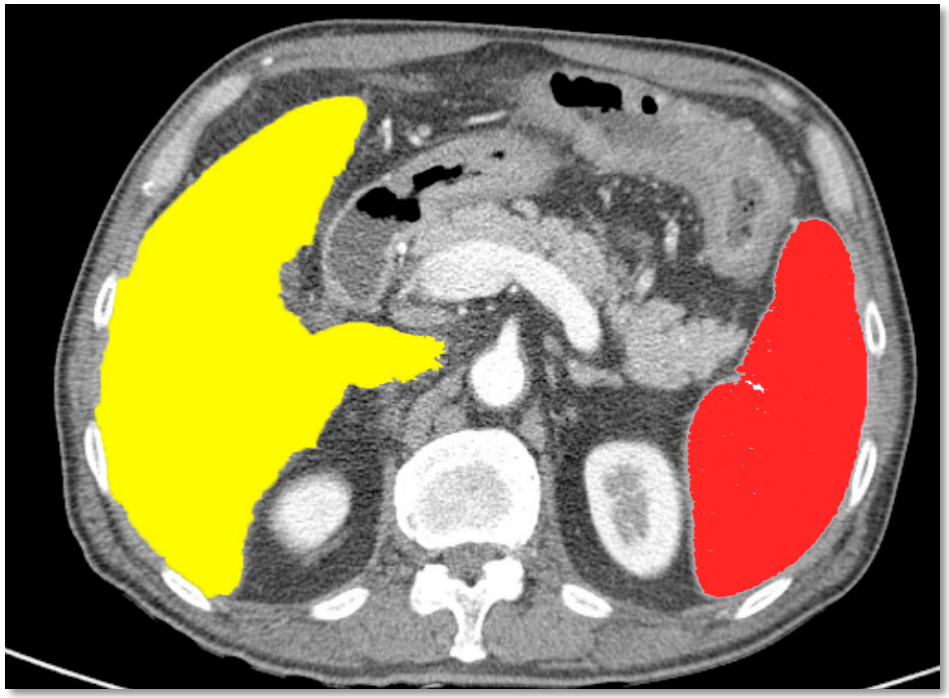
Size from Localizer or Transverse Slice





Segmentation

- Fully automated organ segmentation from axial slices is non-trivial but possible
- Might be useful for more refined tissue factor weighting based estimates of organ dose or total dose rather than depending on nominal procedure type
- Certainly useful for patient-specific Monte Carlo simulations of dose
- Cannot segment beyond reconstructed images (e.g., over-ranging for helical scans, scatter beyond scan extent), but could be used to scale to fit anthropomorphic phantoms



What the modality produces

- Multiple possible DICOM sources

- Radiation Dose Structured Report (RDSR)
- Modality Performed Procedure Step (MPPS)
- Image “header” attributes
- Dose Screen Image (Optical Character Recognition (OCR))

All new CT scanners produce DICOM Structure Reports

- Multiple possible DICOM sources

- Radiation Dose Structured Report (RDSR)
- Modality Performed Procedure Step (MPPS)
- Image “header” attributes
- Dose Screen Image (Optical Character Recognition (OCR))

All new CT scanners produce DICOM Structure Reports

- Multiple possible DICOM sources

- Radiation Dose Structured Report (RDSR)
- Modality Performed Procedure Step (MPPS)
- Image “header” attributes
- Dose Screen Image (Optical Character Recognition (OCR))

RDSR is the “one true way”

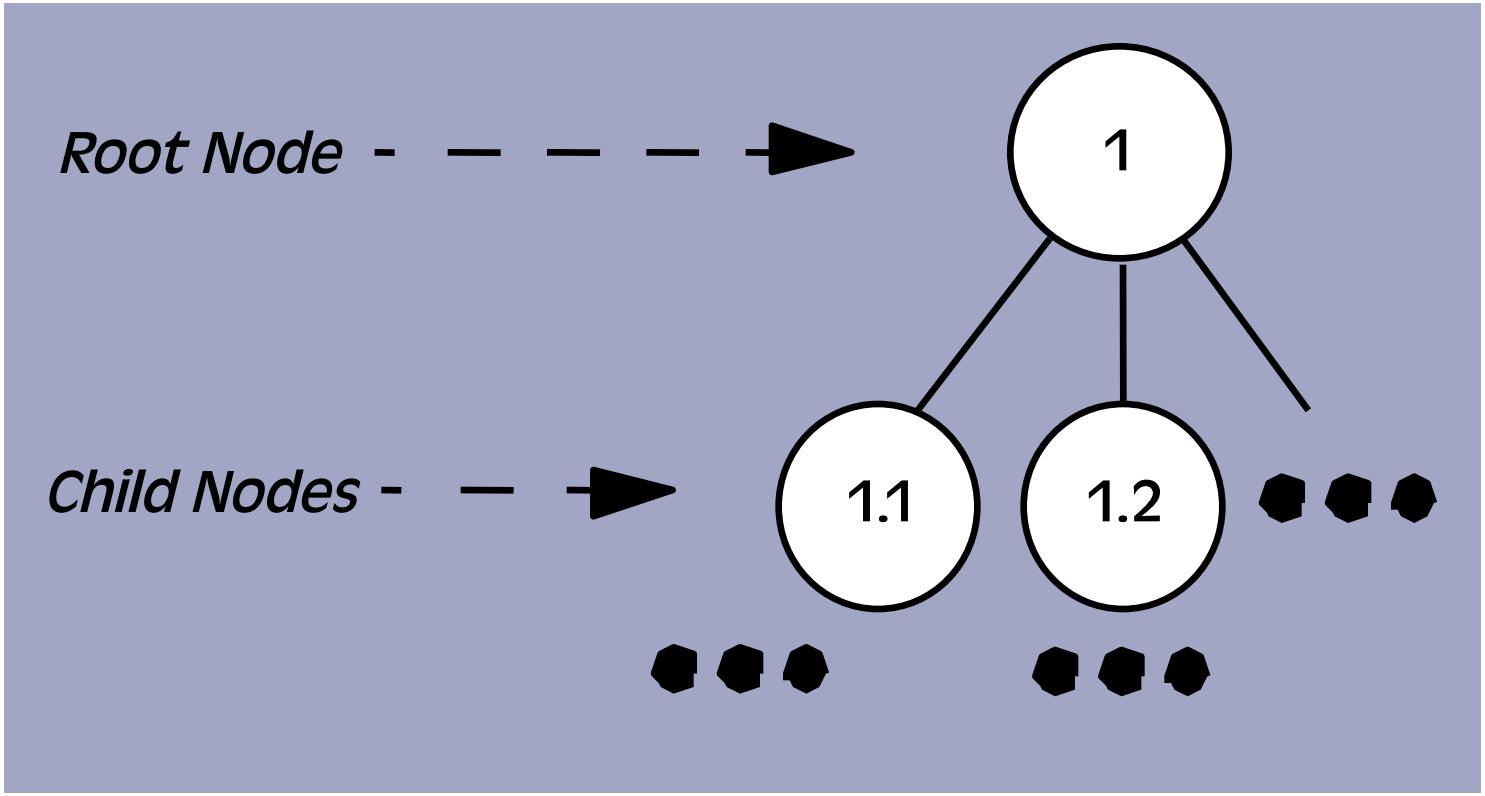
Benefits of Radiation Dose Structured Report (RDSR)

- Persistent document-like object
- Store to PACS, RIS, XDS, CD media
- Extensible, coded, structured content
- Similar to other DICOM “evidence document” for structured content like measurements
- Allows transfer and addition of more content
- Contains accumulated & per event exposure
- Contains detailed technique description

Features of Radiation Dose Structured Report (RDSR)

- General structure common to all modalities
- Specific content for different modalities
- Templates for CT and projection X-Ray
- Fluoroscopy and individual exposures
- Allows a shared infrastructure to manage all ionizing radiation producing diagnostic modalities
- Extended to Nuclear Medicine & PET

SR Content is a Tree



CT RDSR

CT RADIATION DOSE SR IOD TEMPLATES

The templates that comprise the CT Radiation Dose SR are interconnected as in Figure A-12

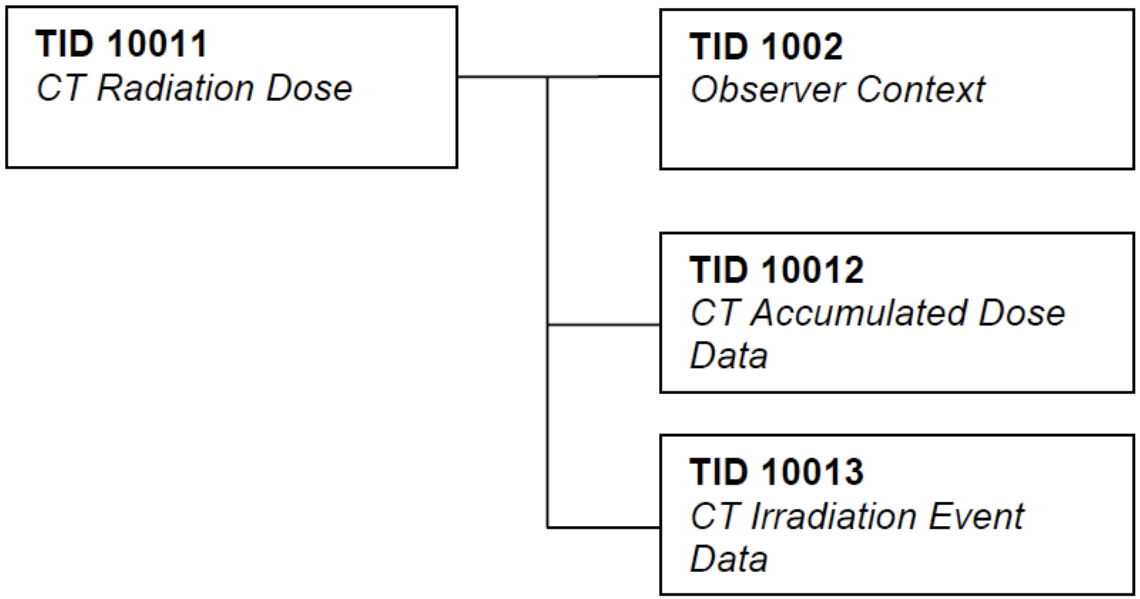


Figure A-12: CT Radiation Dose SR IOD Template Structure

Example DICOM SR Template

TID 10012
CT ACCUMULATED DOSE DATA
Type: Extensible Order: Significant

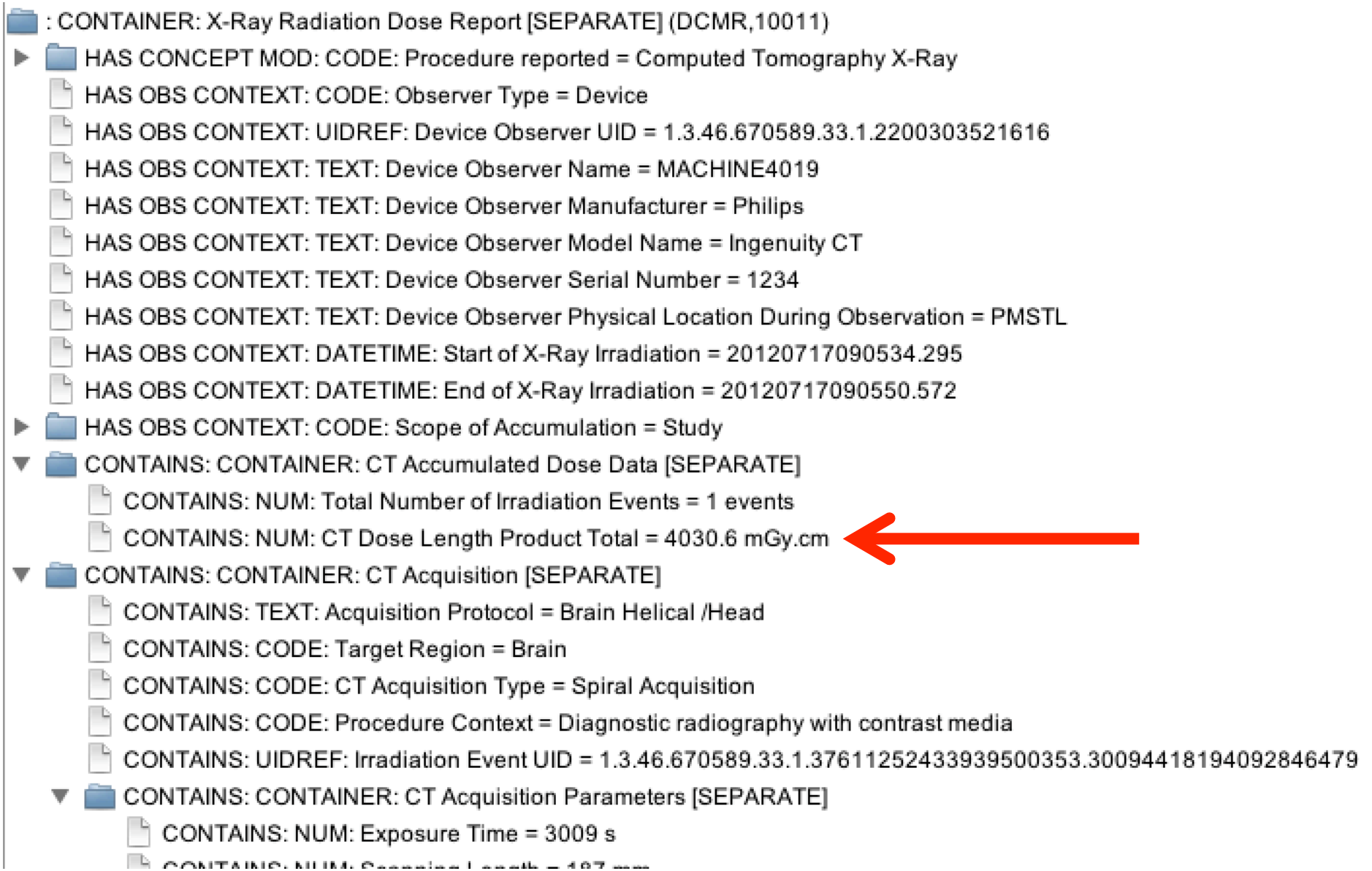
	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (113811, DCM, "CT Accumulated Dose Data")	1	M		
2	>	CONTAINS	NUM	EV (113812, DCM, "Total Number of Irradiation Events")	1	M		Units = EV ({events} UCUM, "events")
3	>	CONTAINS	NUM	EV (113813, DCM, "CT Dose Length Product Total")	1	M		Units = EV (mGy.cm, UCUM, "mGy.cm")
4	>	CONTAINS	NUM	EV (113814, DCM, "CT Effective Dose Total")	1	U		Units = EV (mSv, UCUM, "mSv")
5	>>	HAS PROPERTIES	TEXT	EV (121406,DCM, "Reference Authority")	1	MC	XOR row 6	
6	>>	HAS PROPERTIES	CODE	EV (121406,DCM, "Reference Authority")	1	MC	XOR row 5	DCID (10015) CT Dose Reference Authority
7	>>	HAS	CODE	EV (G-C036,SRT,	1	M		DCID (10011) Effective

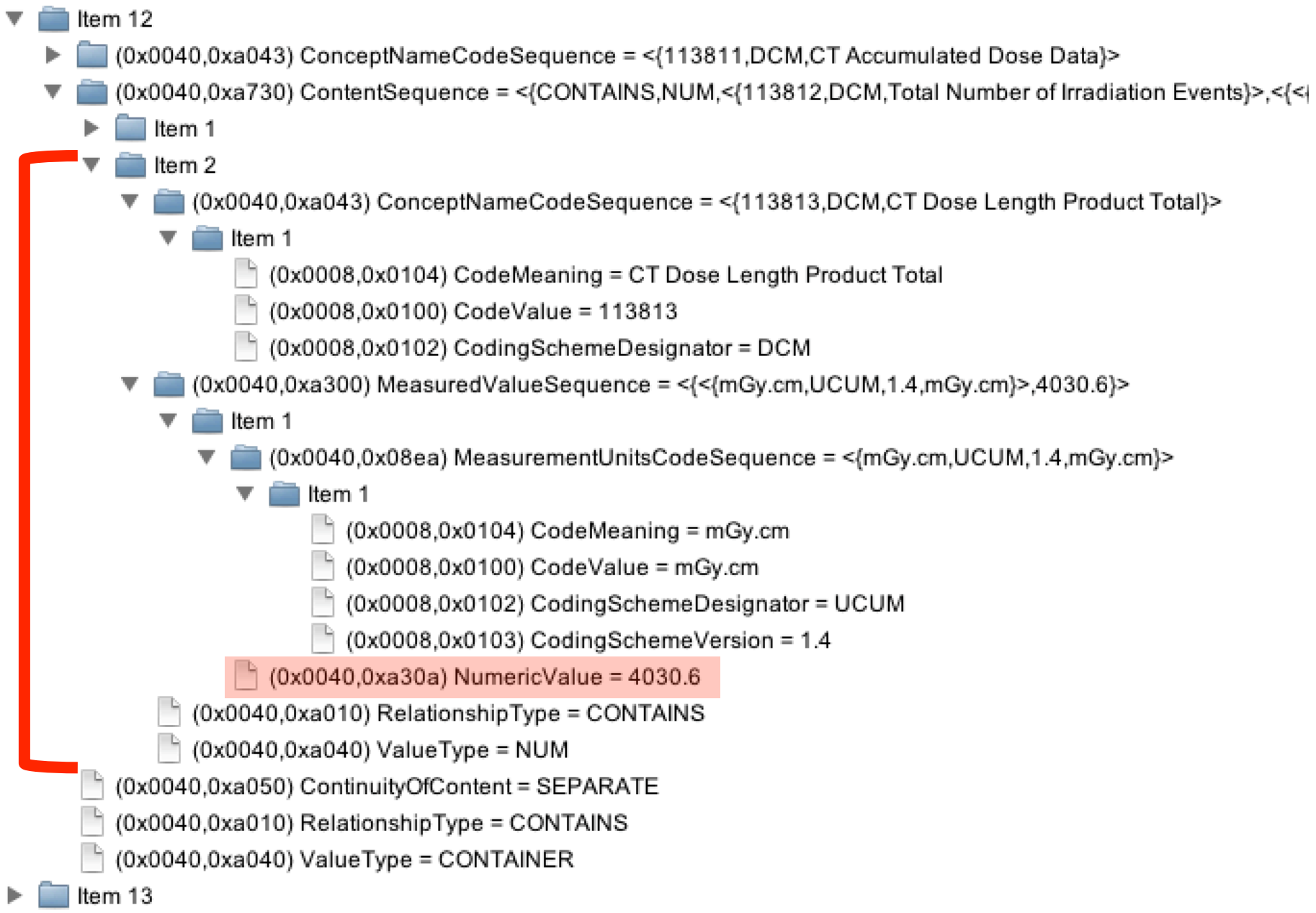
Following slides contain an example of RDSR encoding

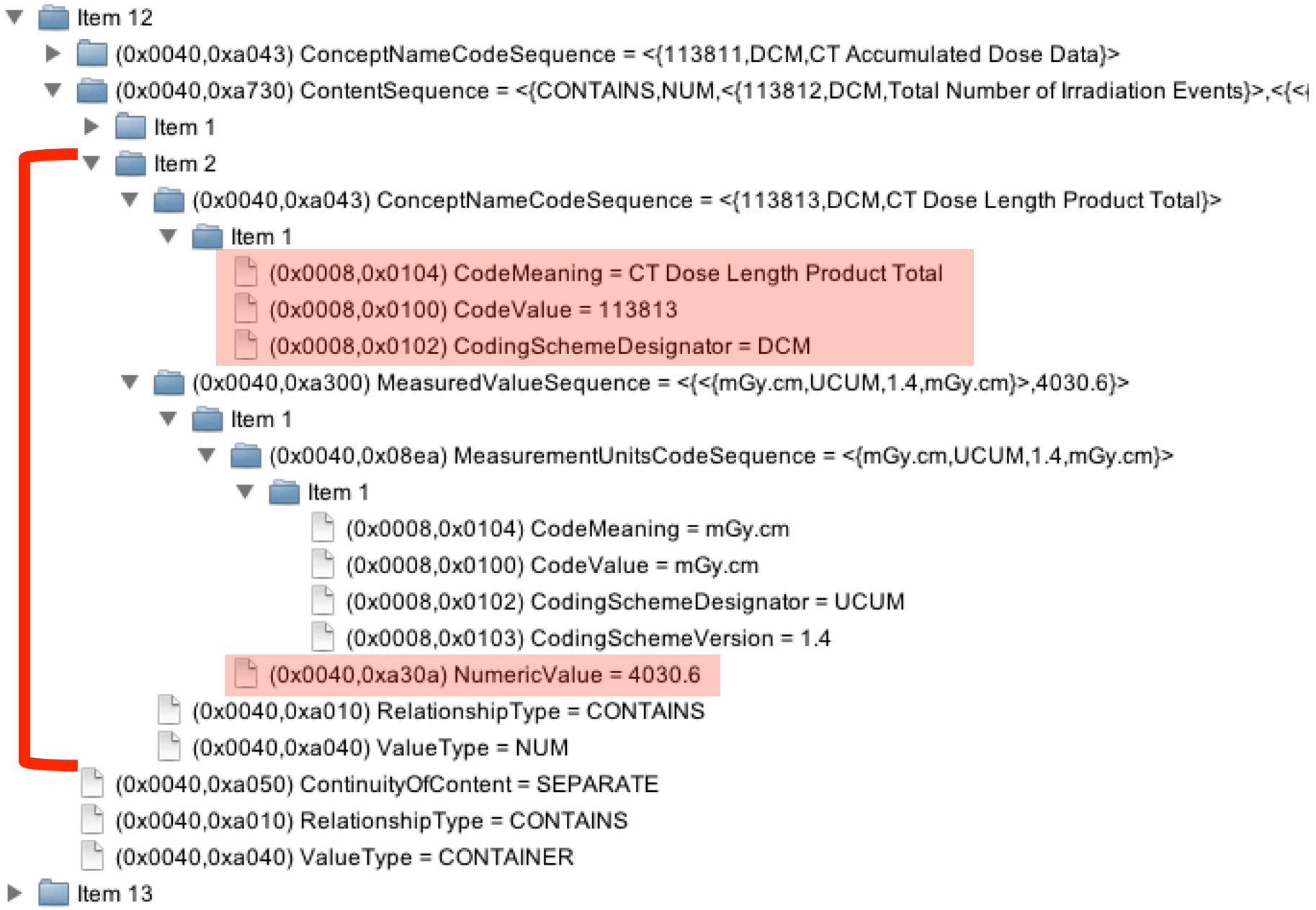
- Content “tree” rendered in a human-readable format by test tool, with nesting shown by indentation

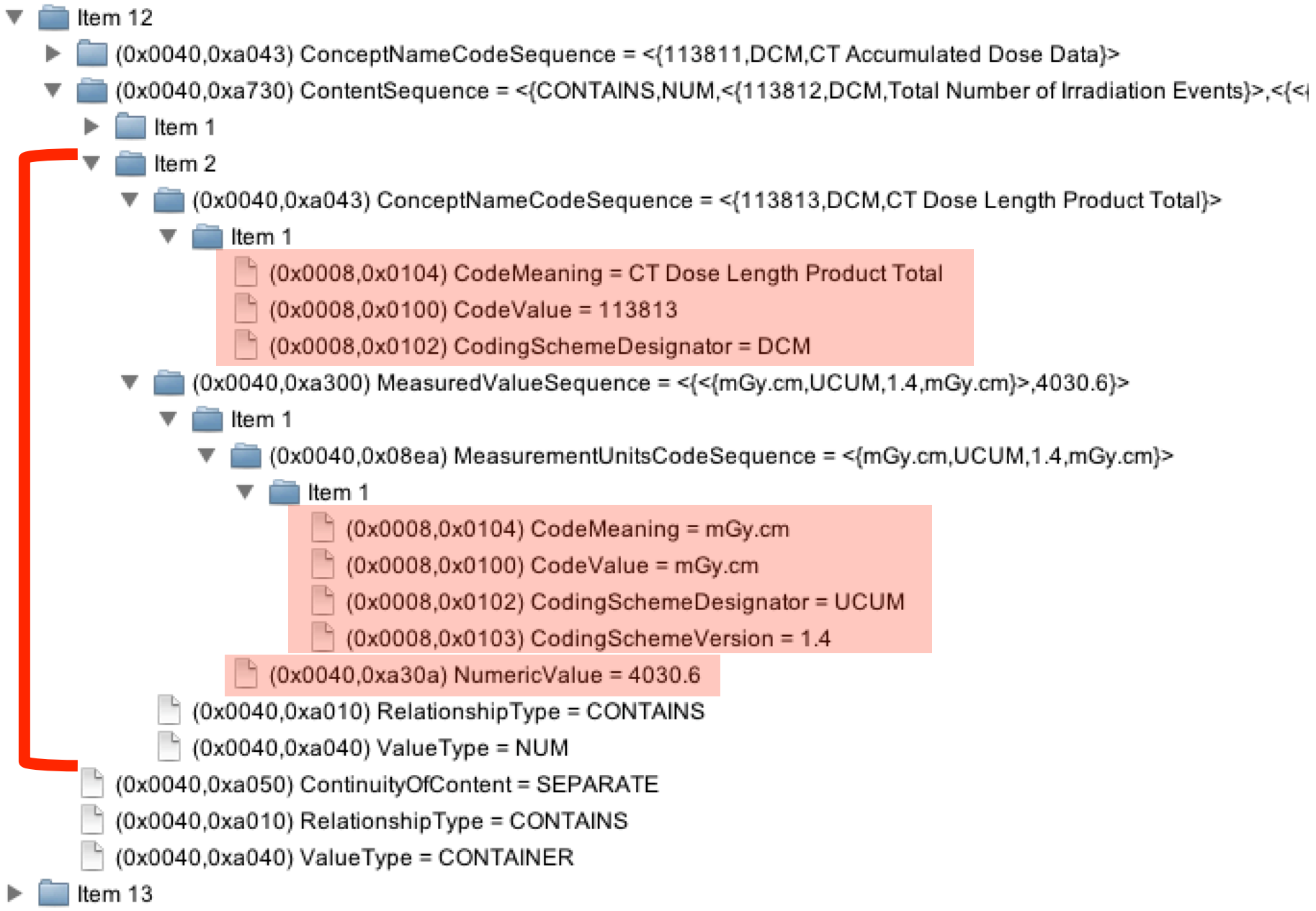
- First at SR “content item” (tree node) level
- Then at DICOM attribute level

- Focus on illustrating the encoding of the value of total DLP


: CONTAINER: X-Ray Radiation Dose Report [SEPARATE] (DCMR,10011)
HAS CONCEPT MOD: CODE: Procedure reported = Computed Tomography X-Ray
HAS OBS CONTEXT: CODE: Observer Type = Device
HAS OBS CONTEXT: UIDREF: Device Observer UID = 1.3.46.670589.33.1.2200303521616
HAS OBS CONTEXT: TEXT: Device Observer Name = MACHINE4019
HAS OBS CONTEXT: TEXT: Device Observer Manufacturer = Philips
HAS OBS CONTEXT: TEXT: Device Observer Model Name = Ingenuity CT
HAS OBS CONTEXT: TEXT: Device Observer Serial Number = 1234
HAS OBS CONTEXT: TEXT: Device Observer Physical Location During Observation = PMSTL
HAS OBS CONTEXT: DATETIME: Start of X-Ray Irradiation = 20120717090534.295
HAS OBS CONTEXT: DATETIME: End of X-Ray Irradiation = 20120717090550.572
HAS OBS CONTEXT: CODE: Scope of Accumulation = Study
CONTAINS: CONTAINER: CT Accumulated Dose Data [SEPARATE]
CONTAINS: NUM: Total Number of Irradiation Events = 1 events
CONTAINS: NUM: CT Dose Length Product Total = 4030.6 mGy.cm
CONTAINS: CONTAINER: CT Acquisition [SEPARATE]
CONTAINS: TEXT: Acquisition Protocol = Brain Helical /Head
CONTAINS: CODE: Target Region = Brain
CONTAINS: CODE: CT Acquisition Type = Spiral Acquisition
CONTAINS: CODE: Procedure Context = Diagnostic radiography with contrast media
CONTAINS: UIDREF: Irradiation Event UID = 1.3.46.670589.33.1.37611252433939500353.3009441819409284647 9
CONTAINS: CONTAINER: CT Acquisition Parameters [SEPARATE]
CONTAINS: NUM: Exposure Time = 3009 s


Item 12
(0x0040,0xa043) ConceptNameCodeSequence = <{113811,DCM,CT Accumulated Dose Data}>
(0x0040,0xa730) ContentSequence = <{CONTAINS,NUM,<{113812,DCM,Total Number of Irradiation Events}>,<{<
Item 1
Item 2
(0x0040,0xa043) ConceptNameCodeSequence = <{113813,DCM,CT Dose Length Product Total}>
Item 1
(0x0008,0x0104) CodeMeaning = CT Dose Length Product Total
(0x0008,0x0100) CodeValue = 113813
(0x0008,0x0102) CodingSchemeDesignator = DCM
(0x0040,0xa300) MeasuredValueSequence = <{<{mGy.cm,UCUM,1.4,mGy.cm}>,4030.6}>
Item 1
(0x0040,0x08ea) MeasurementUnitsCodeSequence = <{mGy.cm,UCUM,1.4,mGy.cm}>
Item 1
(0x0008,0x0104) CodeMeaning = mGy.cm
(0x0008,0x0100) CodeValue = mGy.cm
(0x0008,0x0102) CodingSchemeDesignator = UCUM
(0x0008,0x0103) CodingSchemeVersion = 1.4
(0x0040,0xa30a) NumericValue = 4030.6
(0x0040,0xa010) RelationshipType = CONTAINS
(0x0040,0xa040) ValueType = NUM
(0x0040,0xa050) ContinuityOfContent = SEPARATE
(0x0040,0xa010) RelationshipType = CONTAINS
(0x0040,0xa040) ValueType = CONTAINER
Item 13


Item 12
(0x0040,0xa043) ConceptNameCodeSequence = <{113811,DCM,CT Accumulated Dose Data}>
(0x0040,0xa730) ContentSequence = <{CONTAINS,NUM,<{113812,DCM,Total Number of Irradiation Events}>,<{<
Item 1
Item 2
(0x0040,0xa043) ConceptNameCodeSequence = <{113813,DCM,CT Dose Length Product Total}>
Item 1
(0x0008,0x0104) CodeMeaning = CT Dose Length Product Total
(0x0008,0x0100) CodeValue = 113813
(0x0008,0x0102) CodingSchemeDesignator = DCM
(0x0040,0xa300) MeasuredValueSequence = <{<{mGy.cm,UCUM,1.4,mGy.cm}>,4030.6}>
Item 1
(0x0040,0x08ea) MeasurementUnitsCodeSequence = <{mGy.cm,UCUM,1.4,mGy.cm}>
Item 1
(0x0008,0x0104) CodeMeaning = mGy.cm
(0x0008,0x0100) CodeValue = mGy.cm
(0x0008,0x0102) CodingSchemeDesignator = UCUM
(0x0008,0x0103) CodingSchemeVersion = 1.4
(0x0040,0xa30a) NumericValue = 4030.6
(0x0040,0xa010) RelationshipType = CONTAINS
(0x0040,0xa040) ValueType = NUM
(0x0040,0xa050) ContinuityOfContent = SEPARATE
(0x0040,0xa010) RelationshipType = CONTAINS
(0x0040,0xa040) ValueType = CONTAINER
Item 13


Item 12
(0x0040,0xa043) ConceptNameCodeSequence = <{113811,DCM,CT Accumulated Dose Data}>
(0x0040,0xa730) ContentSequence = <{CONTAINS,NUM,<{113812,DCM,Total Number of Irradiation Events}>,<{<
Item 1
Item 2
(0x0040,0xa043) ConceptNameCodeSequence = <{113813,DCM,CT Dose Length Product Total}>
Item 1
(0x0008,0x0104) CodeMeaning = CT Dose Length Product Total
(0x0008,0x0100) CodeValue = 113813
(0x0008,0x0102) CodingSchemeDesignator = DCM
(0x0040,0xa300) MeasuredValueSequence = <{<{mGy.cm,UCUM,1.4,mGy.cm}>,4030.6}>
Item 1
(0x0040,0x08ea) MeasurementUnitsCodeSequence = <{mGy.cm,UCUM,1.4,mGy.cm}>
Item 1
(0x0008,0x0104) CodeMeaning = mGy.cm
(0x0008,0x0100) CodeValue = mGy.cm
(0x0008,0x0102) CodingSchemeDesignator = UCUM
(0x0008,0x0103) CodingSchemeVersion = 1.4
(0x0040,0xa30a) NumericValue = 4030.6
(0x0040,0xa010) RelationshipType = CONTAINS
(0x0040,0xa040) ValueType = NUM
(0x0040,0xa050) ContinuityOfContent = SEPARATE
(0x0040,0xa010) RelationshipType = CONTAINS
(0x0040,0xa040) ValueType = CONTAINER
Item 13

Example of report rendered from example DICOM RDSR

Date	Modality	Description	DLP Total mGy.cm	DLP HEAD16 mGy.cm	DLP BODY32 mGy.cm	Manufacturer	Model	From
2012/07/17 09:05:34	CT	Brain Helical	4030.6 (HEAD16)			Philips	Ingenuity CT	RDSR MOD

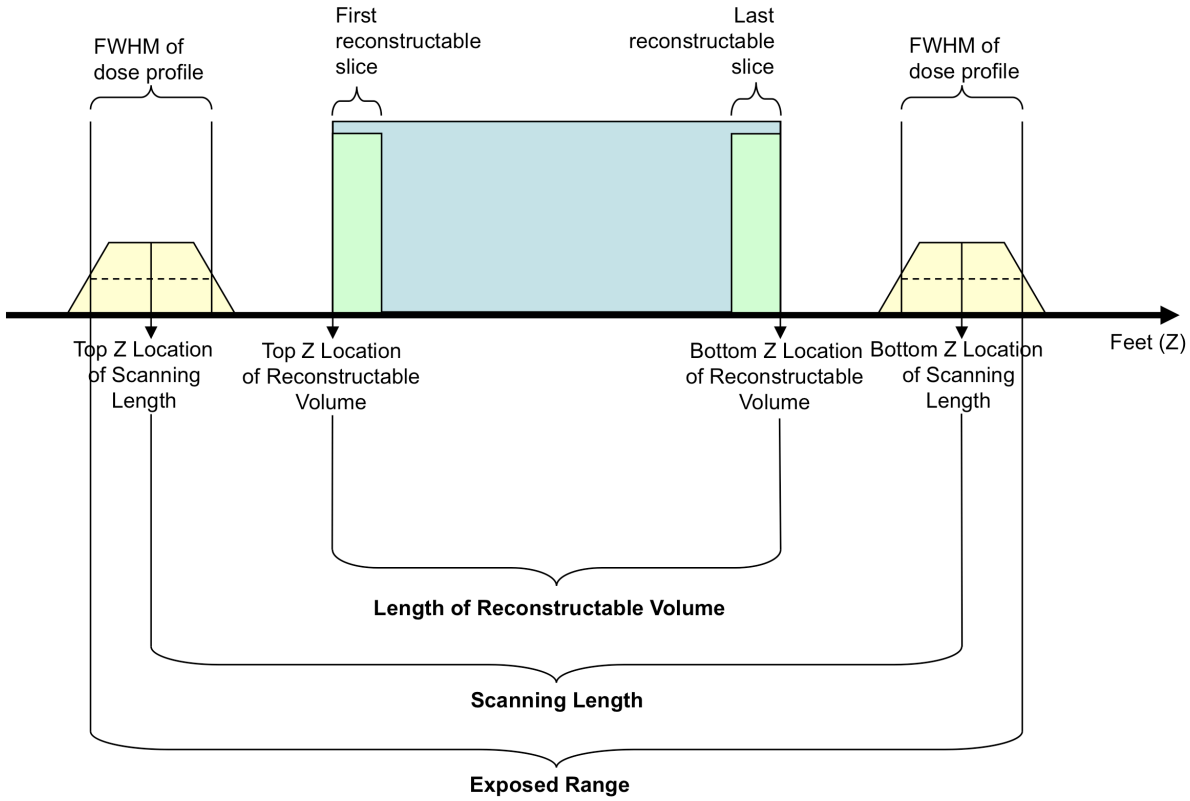
Contents of Radiation Dose Structured Report (RDSR)

- Irradiation event: uniquely identified
- Scope: event, series, PPS, study
- Accumulated & per-event data
- Phantom dose required (CTDIvol, DLP)
- Effective dose (mSv) optional (ICRP 60, 103)
- Per-event acquisition parameters (kVP,…)
- Standard coded region (anatomy)
- Standard coded CT type (sequenced, spiral)

RDSR is Extensible: Optional Items added by CPs

- Spatial extent of scan
  - distinguish over-ranging from reconstructed length
  - description of location (patient-relative coordinates)
- NEMA XR25 Dose Check
  - record alerts, notifications and overrides
  - record settings (thresholds)
- Size-Specific Dose Estimates (SSDE)
  - AAPM Task Group 204
  - CTDIvol modified by effective diameter conversion

CP 1068 Scan Location in CT Dose Reports



But we have a dilemma: scanners without RDSR

- What to do about older scanners?
  - which have not been updated yet, and cannot (will not) be
  - these constitute a large part of global installed base
  - what existing capabilities can be leveraged?
- What about new objects in old PACS?
  - new modalities may produce RDSR, but …
  - PACS cannot store them
  - site has no system to view, aggregate, report
- What about old (pre-RDSR) studies in the archive?
  - vast collection of (useful) reference dose information
  - manual recording is tedious (== expensive)
  - clinical use of prior data for patients with new studies

Many older scanners produce Dose Screen images

- Multiple possible DICOM sources

- Radiation Dose Structured Report (RDSR)
- Modality Performed Procedure Step (MPPS)
- Image “header” attributes
- Dose Screen Image (Optical Character Recognition (OCR))

One of many “possible wrong ways”

Dose Screen – GE

Patient Name: Exam no:

Accession Number:

Patient ID: Discovery CT750 HD

Exam Description: CT HALS/THORAX/ABDOMEN

Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	S15.750-I650.250	5.10	373.00	Body 32
5	Helical	S188.000-I105.000	5.10	182.72	Body 32
			Total Exam DLP:	555.72	

1/1

Key Fields to Extract

Patient Name: Exam no:

Accession Number:

Patient ID: Discovery CT750 HD

Exam Description: CT HALS/THORAX/ABDOMEN

Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	S15.750-I650.250	5.10	373.00	Body 32
5	Helical	S188.000-I105.000	5.10	182.72	Body 32

Total Exam DLP: 555.72

1/1

Additional Fields to Extract

Patient Name: Exam no:

Accession Number:

Patient ID: Discovery CT750 HD

Exam Description: CT HALS/THORAX/ABDOMEN

Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	S15.750-I650.250	5.10	373.00	Body 32
5	Helical	S188.000-I105.000	5.10	182.72	Body 32
			Total Exam DLP:	555.72	

1/1

Available from “header”

Patient Name: Exam no:

Accession Number:

Patient ID: Discovery CT750 HD

Exam Description: CT HALS/THORAX/ABDOMEN

Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	S15.750-I650.250	5.10	373.00	Body 32
5	Helical	S188.000-I105.000	5.10	182.72	Body 32
			Total Exam DLP:	555.72	

1/1

Some older scanners produce MPPS

- Multiple possible DICOM sources

- Radiation Dose Structured Report (RDSR)
- Modality Performed Procedure Step (MPPS)
- Image “header” attributes
- Dose Screen Image (Optical Character Recognition (OCR))

Another “possible wrong way”

Modality Performed Procedure Step is Insufficient

- Compared to RDSR, MPPS has:
  - limited ability to encode complex data
  - is a transient message, nor a persistent object
  - not intended to be “stored” or queried
- Intended to manage scheduling system
  - in that role, perceived as offering little benefit
  - so, not very widely implemented in RIS/PACS

Some older scanners record dose in image attributes

- Multiple possible DICOM sources

- Radiation Dose Structured Report (RDSR)
- Modality Performed Procedure Step (MPPS)
- Image “header” attributes
- Dose Screen Image (Optical Character Recognition (OCR))

Yet another “possible wrong way”

Image "Header" Attributes are Insufficient

- Compared to RDSR:
  - usually describe technique only
    - kVP, mAs, not usually (mean) CTDIvol
    - not DLP, which spans entire acquisition
  - may be multiple reconstructions per exposure
    - soft tissue and bone reconstructions, MPRs
    - might count same dose more than once
  - timing of encoding
    - images encoded/sent before acquisition ends

RDSR for other Modalities than CT

- Projection X-Ray
  - fluoroscopy
  - angiography (including cardiac)
  - mammography
  - “plain” X-Ray – fixed & cassette-based
- Radioisotopes
  - Nuclear Medicine
  - PET

Fluoroscopy and Angiography RDSR

- RDSR effort pre-dates CT (2005 v 2007)
  - interventional concern – skin damage
  - uses the measures defined in IEC 61910-1
  - accumulated and per event
  - dose at reference point, Dose Area Product
  - effective dose is a challenge
- Not as widely available in modalities yet
  - some legacy use of MPPS in modalities
  - can extract from MPPS and record in RDSR

Mammography RDSR

- Mammography-specific reference point (RP)
  - versus IEC “interventional reference point” for XA/XRF
- Entrance dose
- Average glandular dose
  - per event and accumulated
- Laterality
  - dose accumulated separately per breast
- Technique
  - filtration, compression, grid
- Breast composition

“Plain” (Projection) X-Ray RDSR

- Recording technique factors is easy
- “Dose” is hard
  - generality of subject & geometry
  - simplicity of systems
- Use measure of detector sensitivity
  - as a “proxy” for the dose delivered
  - was proprietary & machine-specific
  - now standard IEC 62494 Exposure Index (AAPM TG 116)

Radiopharmaceutical Radiation Dose SR (RRDSR)

- New
  - relatively recently added to DICOM
  - Supplement 159 (June 2014)
  - few vendors yet, and no IHE profile yet
  - especially important for PET/CT, since at least 50% of dose
  - especially important for NM cardiac procedures (very common)
- Differences from RDSR
  - unlike CT/X-Ray, dose is injected not produced by modality
  - so, expected to be created by dose calibrator or in “hot lab” management system (and consumed by modality)
  - for legacy support and dose registry submission can be retrospectively extracted from image “header” attributes about dose
  - records type, amount, timing and related information

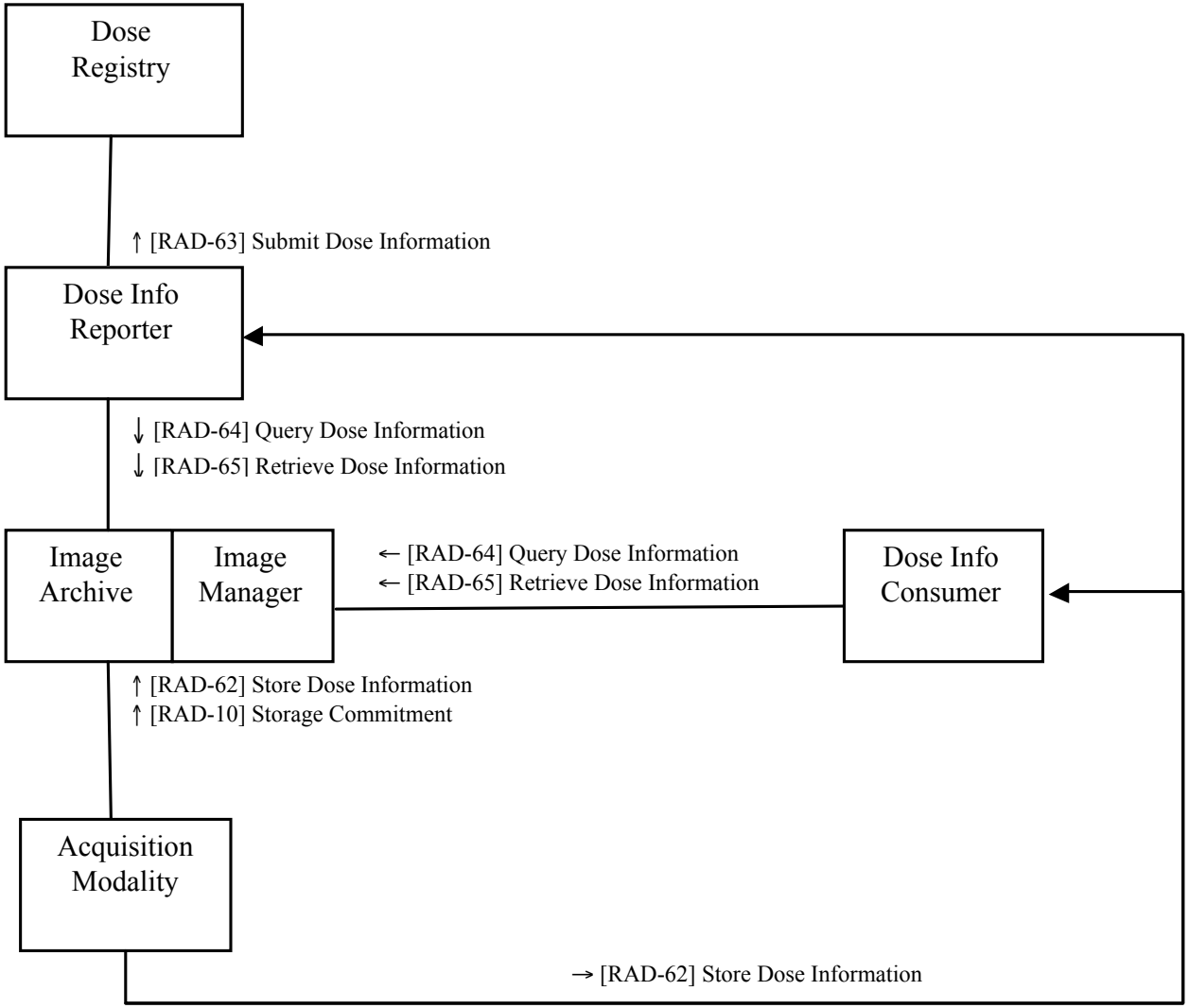
Putting it all together (all the modalities)

- Cannot directly compare
  - CTDIvol and DLP
  - Dose Area Product (DAP)
  - Average Glandular Dose (for breast)
  - radiopharmaceutical dose
  - …
- But can record and collate (in registry)
- “Patient Dose SR” DICOM work item
  - DICOM WG 28 (Physics)
  - work on organ dose, effective dose (recording)

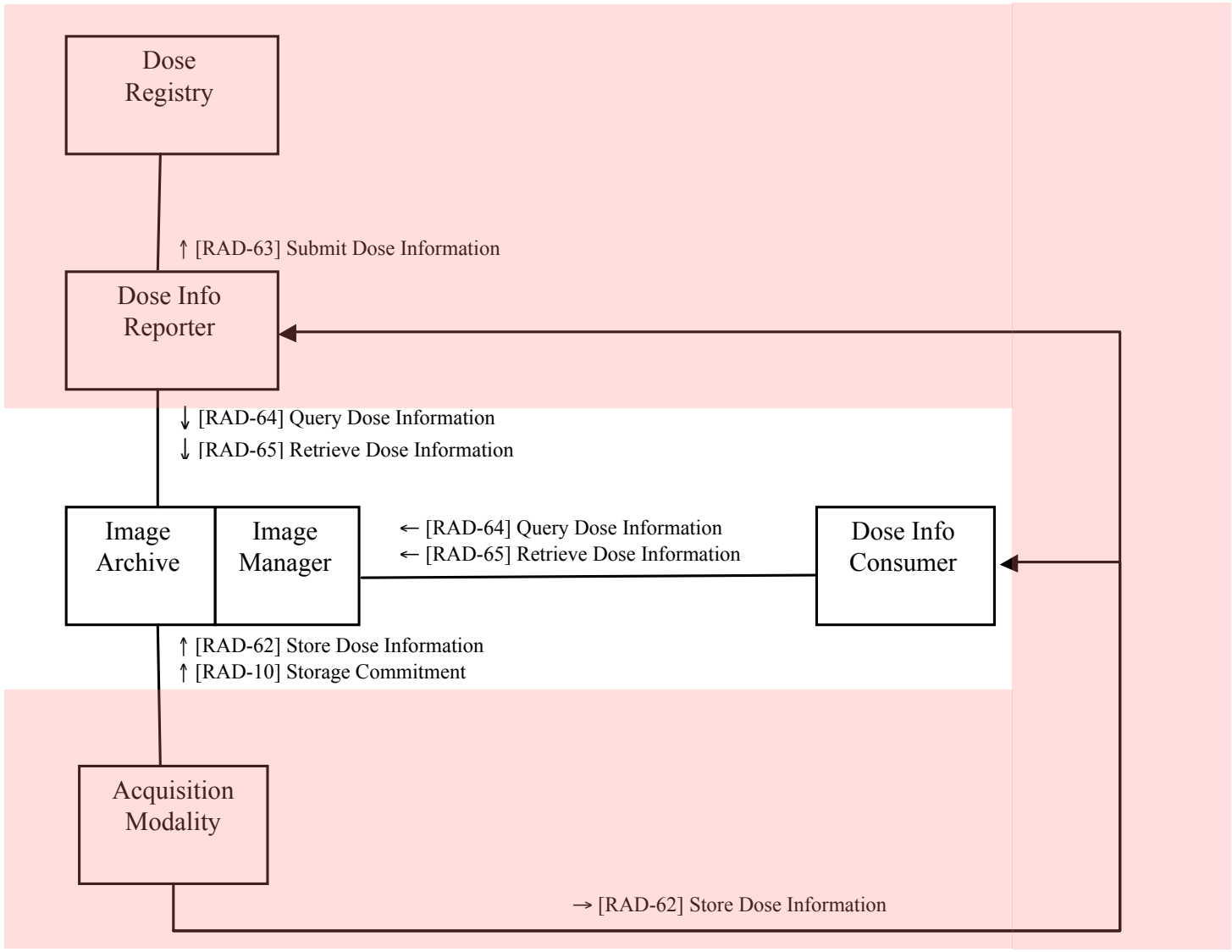
Dose Recording Workflow

- DICOM defines the “payload”
  - what to record, how to record it
- IHE defines the workflow
  - which systems do what for which “use case”
- IHE Radiation Exposure Monitoring (REM) Integration Profile
  - modalities produced DICOM RDSR
  - consumers, reporters, registries use them
  - Image Managers/Archives (PACS) store them

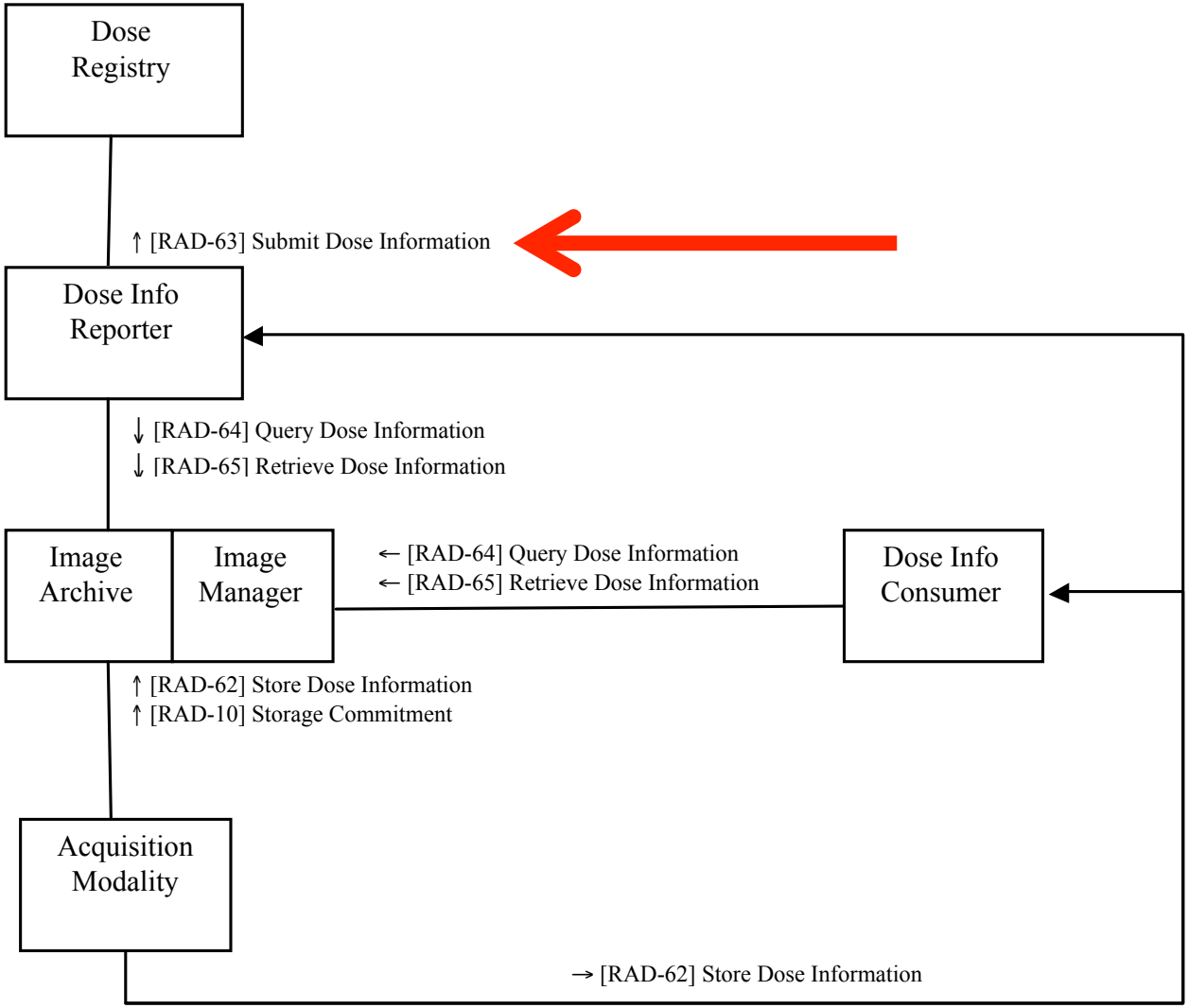
IHE REM Profile



IHE REM Profile and Registry



IHE REM Profile and Registry



IHE REM and Dose Registries

- RAD-63 Transaction
  - Submit Dose Information
    - from Dose Information Reporter
    - to Dose Registry
  - payload is DICOM RDSR
  - RDSR may need to be de-identified
  - various transport mechanisms possible
- May need to send other objects
  - e.g., localizer images for size
  - ? add data to RDSR (e.g., patient size from HL7)

IHE Submit Dose Information – Transport Possibilities

- Secure FTP
  - originally ACR DIR wanted to use secure FTP (SFTP)
  - abandoned – ACR now uses proprietary ACR TRIAD system
  - no other ftp users – remove from IHE REM (CP 200)
- XDR-I
  - SOAP-based HTTP push of DICOM objects (XDS-like)
- DICOM C-STORE
  - conventional DICOM transmission
- DICOM STOW
  - HTTP-based POST of DICOM objects
- XDM
  - email

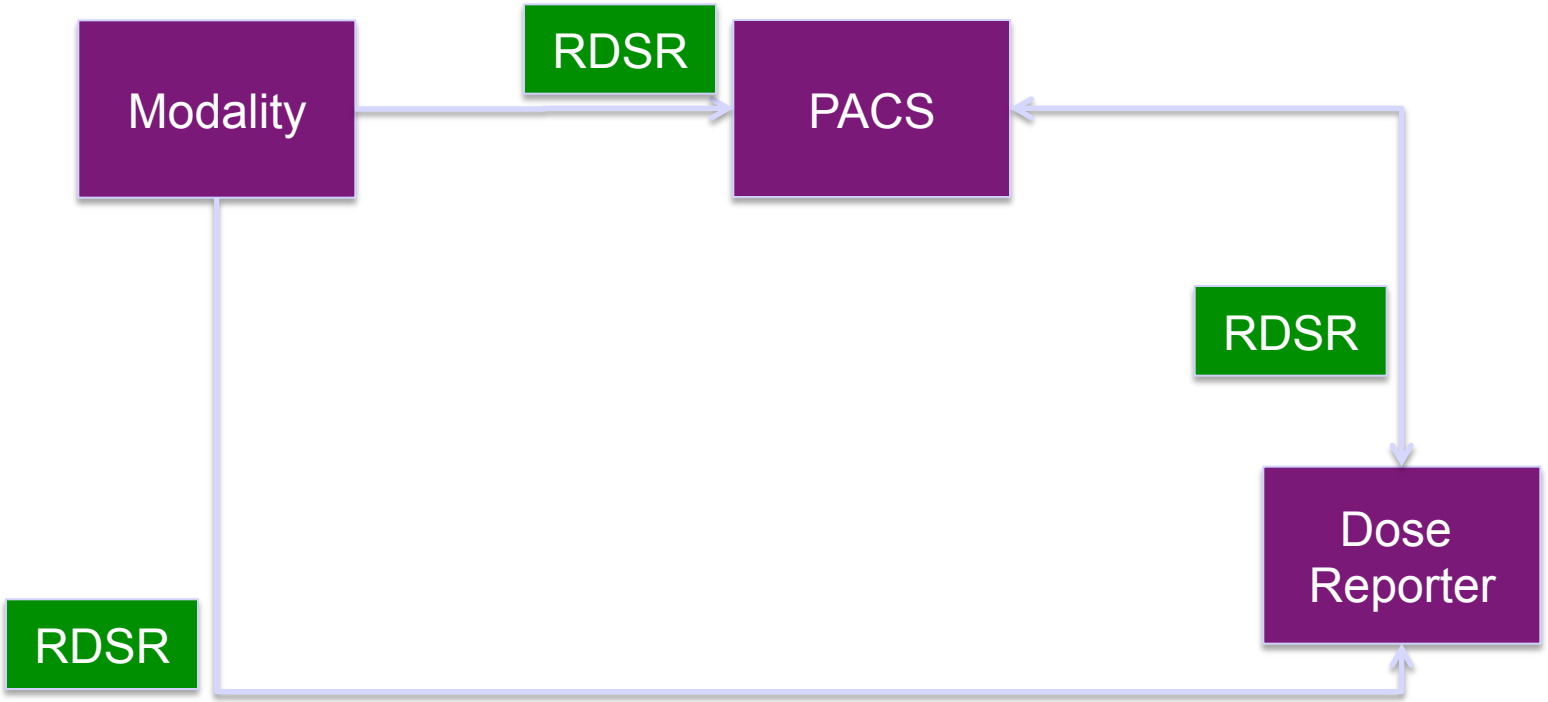
IHE Submit Dose Information – De-identification

- Makes use of DICOM PS3.15 Annex E
  - Basic Application Level Confidentiality Profile
  - specifies what to remove & retain +/- options
  - Retain Longitudinal Option (dates)
  - Retain Patient Characteristics Option (sex, age, size)
  - Retain Device Information Option (CT machine)
  - Retain UIDs Option
- Special considerations
  - identity buried within RDSR content tree
  - same data submitted multiple times (use UIDs)
  - same patient different studies at different times
  - “safe” private data elements and/or SR content items

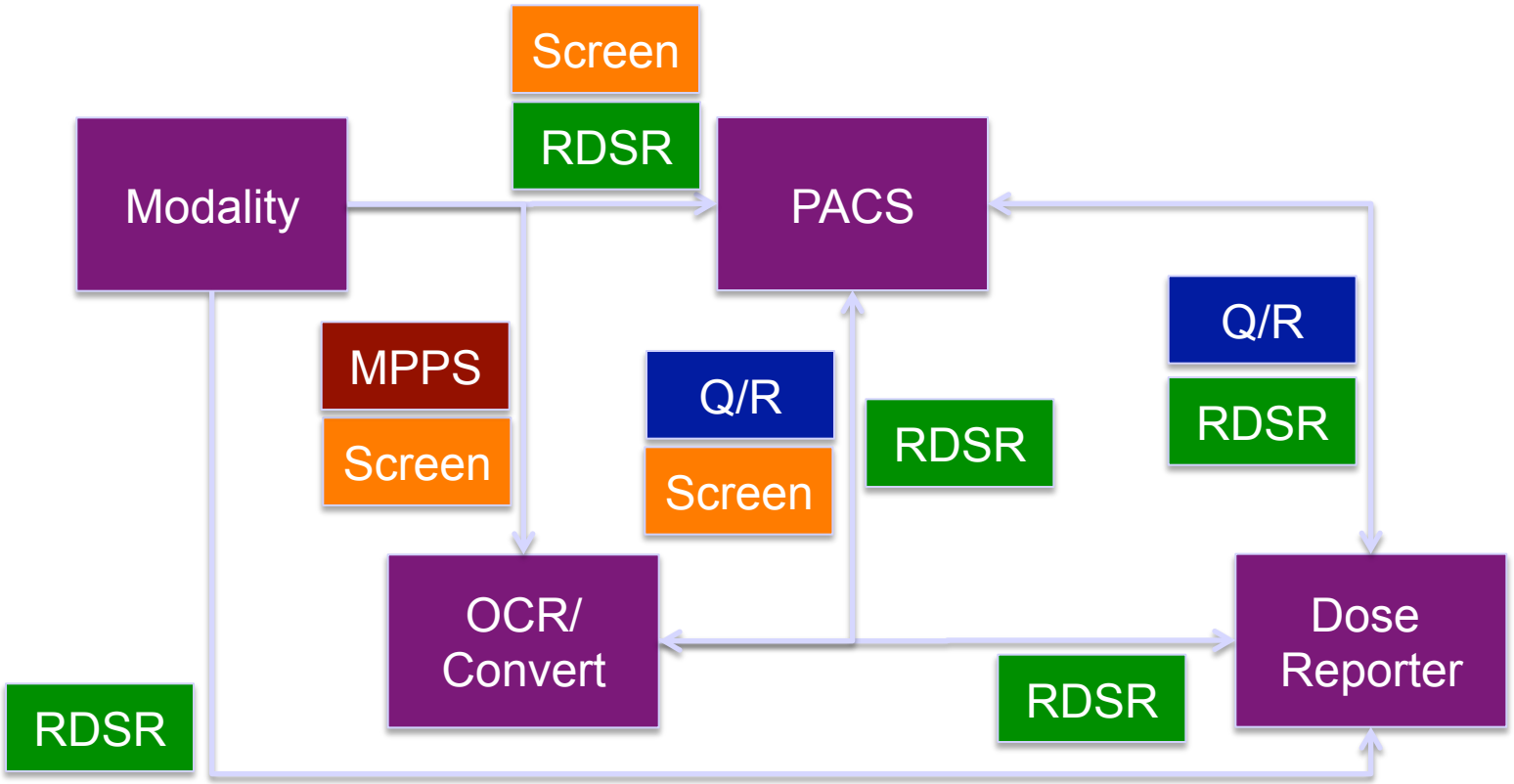
Special Challenges for RDSR Submission to Registries

- Recognition of procedure type
  - need to stratify dose by procedure
  - e.g., CT brain without contrast vs. with contrast vs. perfusion vs. other type of CT head (skull base, facial fracture, …)
  - few sites uses standard codes/text for procedure/anatomy
  - could use JJ1017, SNOMED, LOINC, RadLex Playbook
  - match Study Description text
  - match local codes in Procedure Code Sequence
  - choice to map to standard before or after sending to registry
- Recognition of other relevant variables
  - scan details, e.g., dose modulation, iterative reconstruction

IHE REM only specifies use of DICOM RDSR



Deployment with MPPS and/or OCR as well as RDSR



DICOM Dose Encoding Summary

- DICOM encoding of machine output and relevant patient information
- Preferred mechanism is Radiation Dose Structured Report (RDSR)
- Multiple modalities are supported (not just CT)
- Creation of RDSR for registries from obsolete mechanisms (OCR, of dose screens, image attributes, MPPS)
- IHE Radiation Exposure Monitoring (REM) as basis for workflow (within enterprise and for registry)
- Registry submission transport mechanisms
- De-identification (DICOM standard profile/options)
- Registry submission issues, especially procedure recognition

Final Notes – Useful Links

- DICOM Standard for RDSR
  - http://dicom.nema.org/medical/dicom/current/output/chtml/part16/sect_XRayRadiationDoseSRIODTemplates.html
  - http://dicom.nema.org/medical/dicom/current/output/chtml/part16/sect_CTRadiationDoseSRIODTemplates.html
  - http://dicom.nema.org/medical/dicom/current/output/chtml/part16/sect_RadiopharmaceuticaRadiationDoseSRIODTemplates.html
- IHE REM (with links to profile, DICOM standard, and CPs
  - http://wiki.ihe.net/index.php?title=Radiation_Exposure_Monitoring
- DICOM De-identification
  - http://dicom.nema.org/medical/dicom/current/output/chtml/part15/chapter_E.html
- Medical Imaging Radiation Dose Informatics site/group
  - http://sites.google.com/site/medimgraddoseinformatics/