



Standards in Medical Imaging: A Tale of Two Layers

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MEDICAL**

Made For life

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DICOM : Traditional Data Standard

- Defining how to encode and exchange information with unambiguous semantics
- Broad scope
 - Intentionally addresses MANY use cases
 - “Swiss Army Knife”
 - Generalize, inclusive,
- Priority: make most/all things possible
 - You decide how to apply it to your problem



IHE : Profiling

- Profiling: Describing the application of existing standards to address a specific use case
- Narrower Scope:
 - Focus on ONE use case
- Constrain Underlying Standards
 - Select among alternative methods
 - Remove/reduce optionality
- Priority: Interoperability; common usage



IHE in One Slide

- IHE helps vendors implement & test functions that span multiple systems
- Profiles are implementation guides
 - how to use existing standards
 - to address a specific problem scenario
- Connectathons are test events
 - managed testing of Profile implementations
- IHE helps users purchase & integrate multi-system solutions
 - list required IHE Profile support in RFPs



DICOM & IHE Similarities

- Open Process
 - Permit & encourage participation by all stakeholders
 - Public Comment for wider input
- Freely Available
 - dicom.nema.org
 - www.ihe.net
- Ongoing Development
 - Maintenance & extension process
 - New supplements every year



DICOM & IHE - Differences

DICOM	IHE
Open-ended development	Annual cycle
Published ~5 times per year	Published annually
DICOM Conformance Statement - Detailed functionality (Long)	IHE Integration Statement - Profile/Actor summary (Brief)
Occasional implementation demos	Annual Connectathon test events
Central oversight (WG-6)	Varies by domain

Examples of Layering

- Simple Case: Radiation Records
 - Adding Architecture
 - DICOM Radiation Dose Structured Report object
 - IHE Radiation Exposure Monitoring Profile
- Advanced Case: Imaging Workflow
 - Assembling Services
 - DICOM Worklists + DICOM MPPS + DICOM Storage + DICOM Storage Commitment
 - IHE Scheduled Workflow Profile
 - Bridging Standards
 - HL7 Orders -> DICOM Worklists

DICOM RDSR

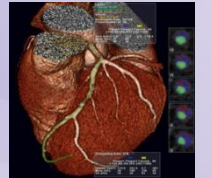
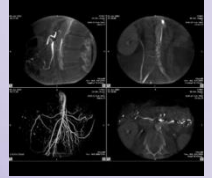
Radiation Dose Structured Report Object

TID 10013
CT IRRADIATION EVENT DATA
Type: Extensible Order: Significant

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (113819, DCM, "CT Acquisition")	1	M		
2	>	CONTAINS	TEXT	EV (125203, DCM, "Acquisition Protocol")	1	U		
3	>	CONTAINS	CODE	EV (123014, DCM, "Target Region")	1	M		DCID (4030) CT and MR Anatomy Imaged
4	>	CONTAINS	CODE	EV (113820, DCM, "CT Acquisition Type")	1	M		DCID (10013) CT Acquisition Types
5	>	CONTAINS	CODE	EV (G-C32C, SRT, "Procedure Context")	1	U		DCID (10014) Contrast Imaging Technique
6	>	CONTAINS	UIDREF	EV (113769, DCM, "Irradiation Event UID")	1	M		
7	>	CONTAINS	CONTAINER	EV (113822, DCM, "CT Acquisition Parameters")	1	M		
8	>>	CONTAINS	NUM	EV (113824, DCM, "Exposure Time")	1	M		Units = EV (s, UCUM, "s")
9	>>	CONTAINS	INCLUDE	DTID (10014) Scanning Length	1	M		
10	>>	CONTAINS	NUM	EV (113826, DCM, "Nominal Single Collimation Width")	1	M		Units = EV (mm, UCUM, "mm")
11	>>	CONTAINS	NUM	EV (113827, DCM, "Nominal Total Collimation Width")	1	M		Units = EV (mm, UCUM, "mm")
12	>>	CONTAINS	NUM	EV (113828, DCM, "Pitch Factor")	1	MC	IF row 4 equals (P5-08001, SRT, "Spiral Acquisition") or equals	Units = EV (ratio), UCUM, "ratio")

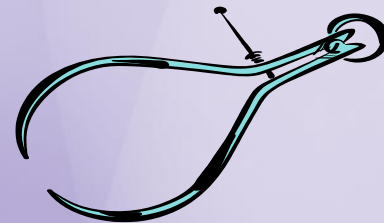
DICOM Dose Reports

- “SR Objects” – DICOM Structured Reports
 - Easily ingested (and regurgitated) by PACS
- Granularity : “Irradiation Event”
 - & Accumulated Dose over Study, Series
- Templates :
 - CT, Projection X-Ray (Mammo, Fluoro, DR/CR)
 - PET/NM
- Not addressed: RT



Key Measurements

- CT Dose
 - DLP, CTDIvol, kVP, mA, sec, ...
 - SSDE [Optional; see AAPM 204]
- Projection X-Ray Dose
 - DAP, Dose@RP, kVP, mA, sec, Fluoro Time, ...
 - CR/DR: Exposure Index, Deviation Index
- Mammography Dose
 - AGD, Entrance Exposure@RP, kVP, mA, sec, ...
 - Compression, Half Value Layer
- Nuclear Medicine (New)
 - Administered Activity, Date/time, Route of Administration, ...



Other Details in Dose SR

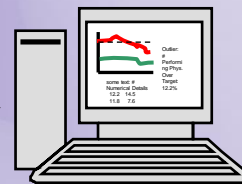
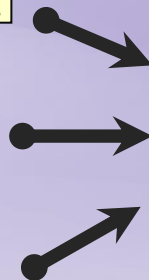
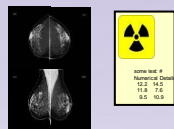
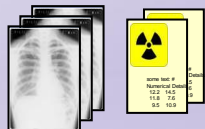
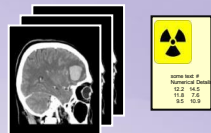
- Full Patient / Order / Study Details
- Unique ID for each Irradiation Event
- Equipment ID, Ordering Doc, Performing Tech
- Patient Size, Orientation, Anatomy Imaged
- Imaging Geometry
- X-Ray Filtering & Collimation Details
- Anode Target Material
- Calibration, Phantom, Dosimeter, Patient Model

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IHE REM Profile

Radiation Exposure Monitoring



Trip to IKEA



- Off-the-shelf...
 - 43 vendors passed IHE Connectathon testing
 - 34 modality products (CT, XA, DR, MG)
 - All major CT vendors shipping in 2012
 - 26 archive products, 18 dose “consumers”
 - 9 dose reporters, 4 dose registry
- NEMA XR-25 & 29 – CT Dose Check, etc
 - All new CT products

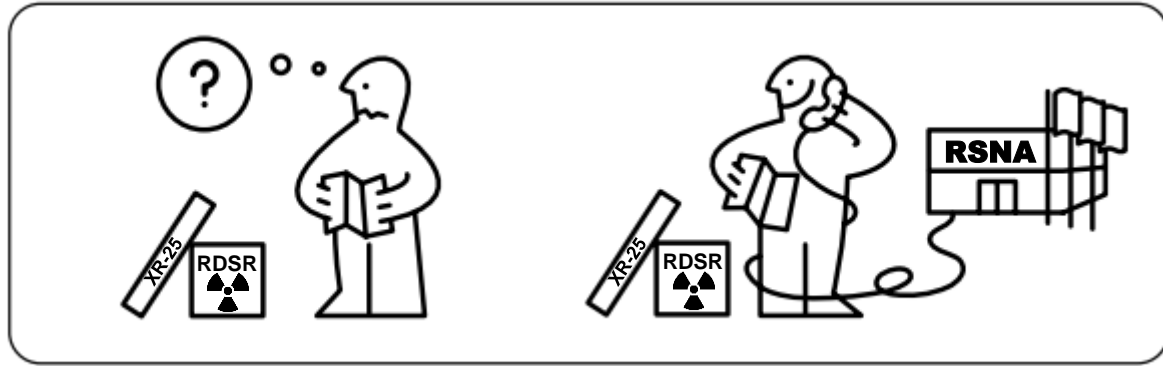
IHEREM



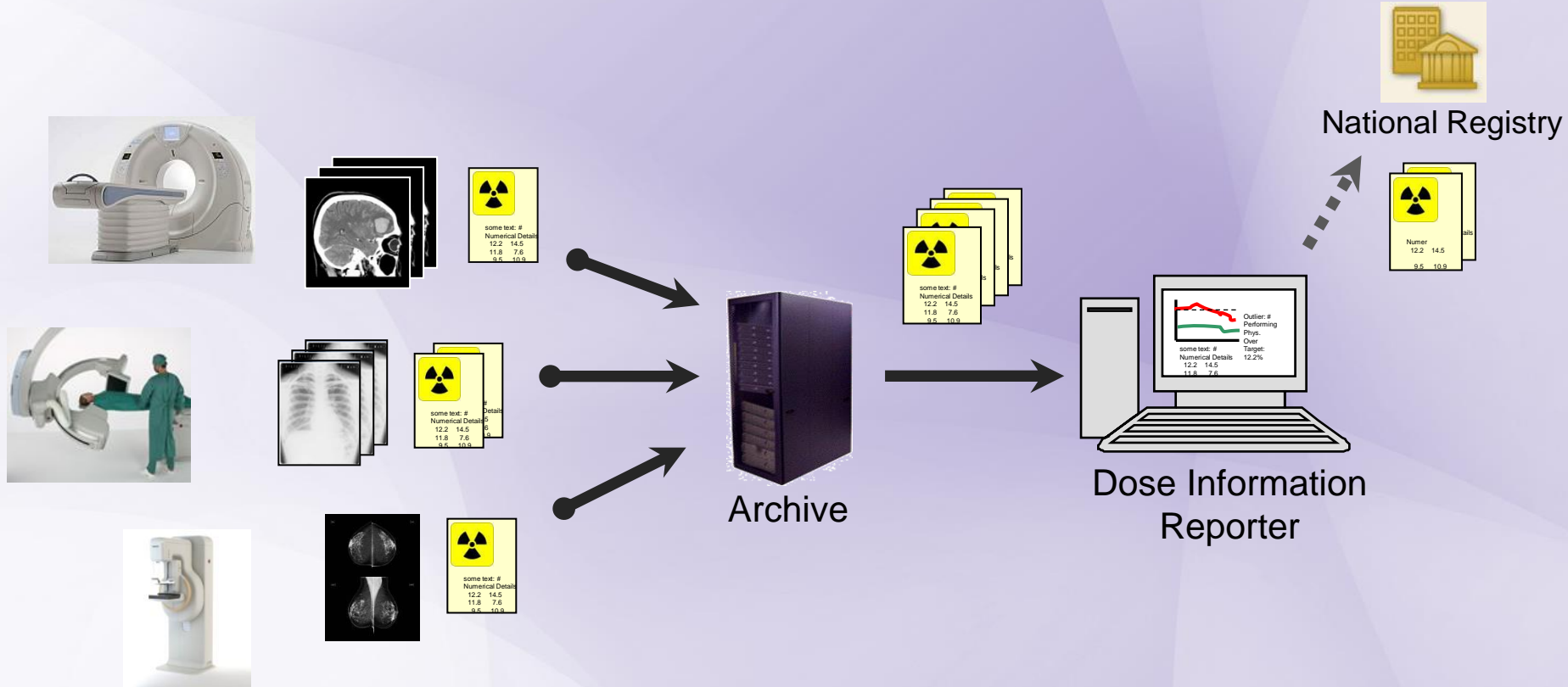
I ntegrating the
H ealthcare
E nterprise

R adiation
E xposure
M onitoring

The pieces exist; Assembly is straightforward



IHE Radiation Exposure Monitoring Profile



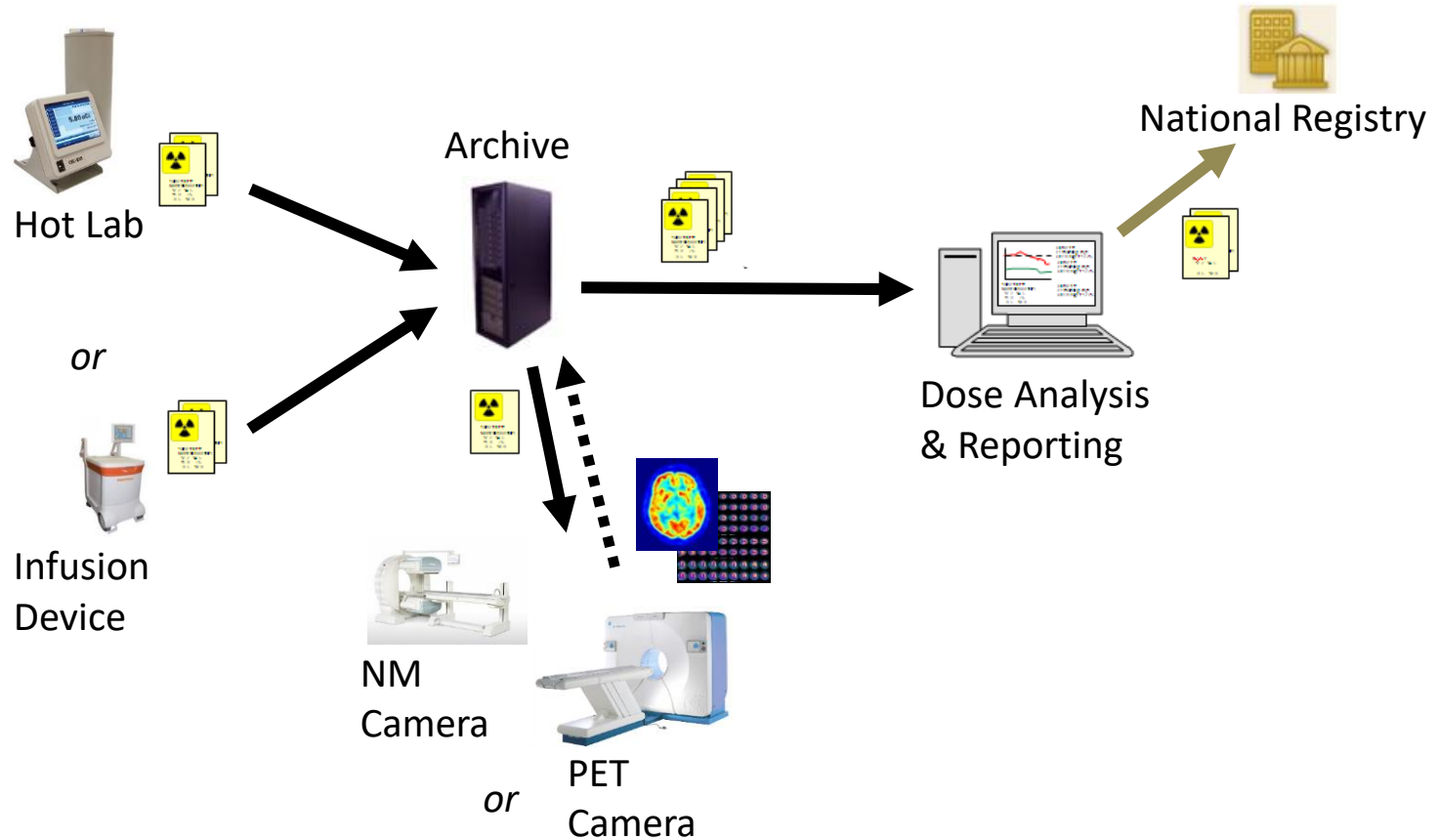
Using SR Dose Reports

- Radiation QA
 - Periodically Query / Retrieve Reports from Archive
 - Set policies/standards and flag deviations
 - Set goals for improvement and track progress
 - Implement protocol changes and compare difference in dose
- Regulation
 - E.g. Automatically insert dose metrics into diagnostic reports
- Patient Impact Evaluation
 - E.g. if Patient identified after the scan as pregnant
- Dose Mapping
 - Store data in realtime from Modality to Mapping Workstation

Using SR Dose Reports

- National Registries
 - Anonymize and submit Dose Reports to Registry
 - Compile Population Risk Estimations
 - Derive Dose Reference Levels (DRLs)
 - Provide Site-Site Comparisons
- Individual Dose Record
 - Collect Dose Reports over time
- Clinical Trials
 - Collect Dose together with Images
 - Demonstrate both improved detection & reduced dose

IHE REM-NM Profile (2016)



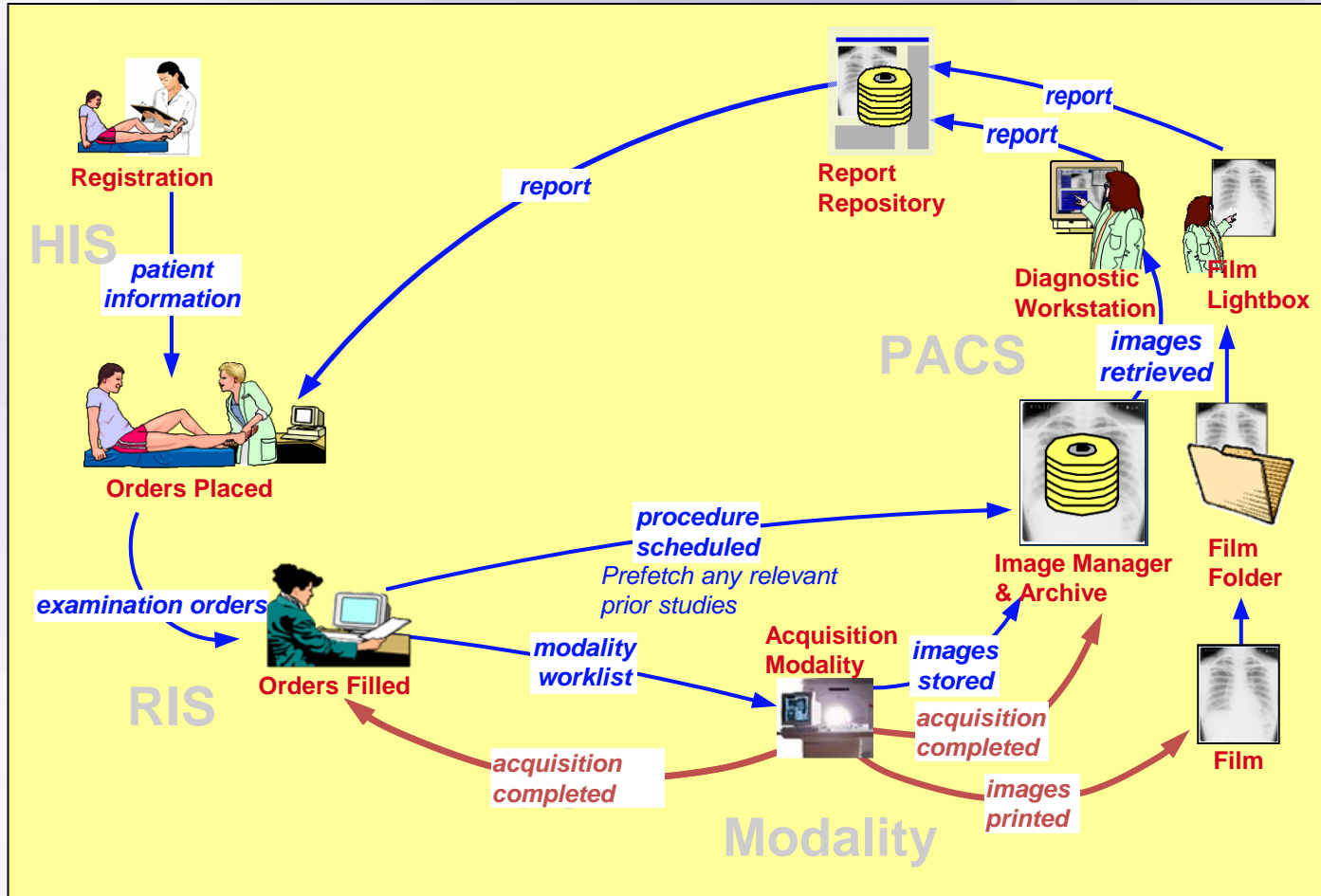
Finding Products

- IHE REM
 - Testing: IHE Connectathon <http://connectathon-results.ihe.net>
 - Product: IHE Integration Statement <http://product-registry.ihe.net>
- DICOM RDSR
 - Product: DICOM Conformance Statement
- NEMA XR-25 Dose Check
 - Vendor commitment; all new products

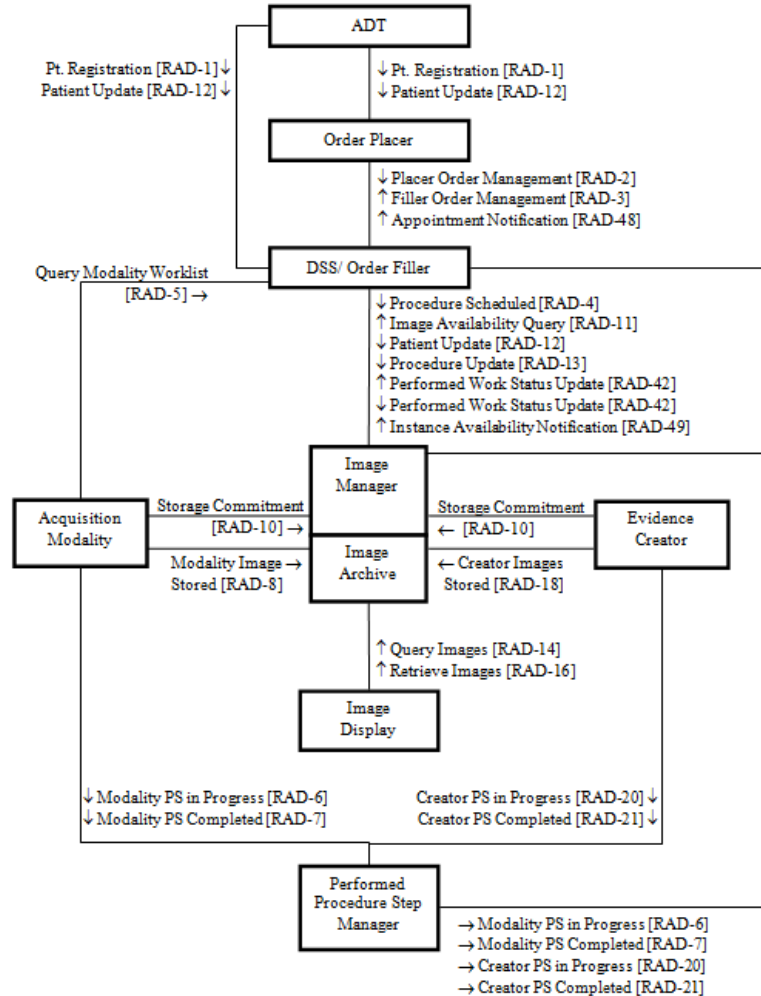
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Scheduled Workflow Profile



Actor / Transaction Diagram*



* Now with improved symmetry

Key DICOM Services

- DICOM Modality Worklist
 - Provide demographics and order details
- DICOM Modality Performed Procedure Step (MPPS)
 - Provide logging/tracking of procedure status
- DICOM Storage Commitment
 - Provide confirmation of data storage
- DICOM Instance Availability Notification
 - Provide notification of data availability

Modality Worklist – Query

- Modality (SCU) queries RIS (SCP)
 - Query can include filters: (AKA Matching Key Attributes)
 - Date/Time of Study
 - Patient Name, ID
 - Accession #
 - Performing System Name
 - Modality
 - Etc.
 - May indicate desired Return Key Attributes
 - Query strategies
 - Narrow query – try to just get specific results
 - Broad query – do additional result filtering on the modality

MPPS – In Progress

- Indicates a procedure step is In Progress
- Timing is not prescribed
 - SCU may send at “start of procedure”
 - SCU may send after completion
- Tracking Attributes
 - Accession#, SPS ID, Study UID
 - Patient Demographics, etc
 - Logical to populate these from the Modality Worklist
- May provide progress details
 - Data produced
 - Protocol codes performed
- Implicit “Notification” of unscheduled/trauma cases
 - MPPS does not correspond to any SPS
 - SCP may choose to “backfill” an order or perform other reconciliation

MPPS – Usage

- **Billing**
 - Details of procedures actually performed
 - Can bill sooner and more accurately
- **Procedure Status Monitoring**
 - Ordering physician can see if started/acquired/cancelled
- **Workflow**
 - Radiologist can see exams pending/ready for reading
- **Patient Tracking**
 - Know where patient is/was at a certain time
- **Key Benefits**
 - Accurate, detailed data on performed steps
 - Can provide up to date status

Storage Commitment – Usage

- Modality requests after storage complete
- Catches network outage losses
- Catches PACS outage losses
- Catches “I thought the morning shift staff sent all their studies to PACS” losses
- Key Benefits
 - Reduces lost data
 - Eliminates manual confirmation time

Mapping HL7 Order to DICOM MWL

DICOM Attribute	DICOM Tag	HL7 Description	HL7 v2.3.1 Segment	HL7 v2.5.1 Segment	Notes
Patient's Name	(0010,0010)	Patient Name	ORM PID:5	OMG PID:5	See note 10
Patient ID	(0010,0020)	External Patient ID	ORM PID:3.1	OMG PID:3.1	See note 5
Issuer of Patient ID	(0010,0021)	External Patient ID	ORM PID:3.4	OMG PID:3.4	See note 5
Medical Alerts	(0010,2000)	Relevant Clinical Info	ORM OBR:13	OMG OBR:13	
Requesting Physician	(0032,1032)	Ordering Provider	ORM OBR:16	OMG OBR:16	
Accession Number	(0008,0050)				Generated by the department system scheduler
Reason for the Requested Procedure	(0040,1002)	Reason for Study	ORM OBR:31	OMG OBR:31	May be a code or text; if code, then code meaning (display name) should be used; see also (0040,100A)

A Profile in Two Parts

- Scheduled Workflow (SWF)
 - Order & acquisition workflow
 - ADT, HIS, RIS, PACS, Modality, Workstation
 - “Backbone of Radiology”
 - Electronic orders, worklists
 - Dataflow, tracking
 - Avoid manual entry, custom interfaces
 - “Close the loop”
 - Value proposition
 - Reduce errors
 - Improve throughput
 - Reduce costs
- Patient Info Reconciliation (PIR)
 - Patient identity changes
 - ADT, HIS, RIS, PACS
 - “Second half of SWF”
 - Propagate and coordinate demographic changes
 - Keep all systems on the same page
 - Value proposition
 - Reduce errors
 - Improve throughput
 - Reduce costs

Participate !

DICOM & IHE invite new members & contributors

- Application process; Patent disclosure policy
- dicom.nema.org
- dicom@medicalimaging.org
- www.ihe.net
- radiology@ihe.net

Great opportunity to learn

Great opportunity to contribute



Questions?