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Deep dive into MWL & UPS: Beyond basic workflow

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Leading Innovation >>>

Modality Worklist evolution - Solomon Unified Worklist and Procedure Step – O'Donnell

Modality Worklist (MWL) maintains the link between DICOM processes and the patient record in the EHR system – this is **Patient Safety Data!**

Ever more critical as healthcare IT integrates

Requirements and expectations have changed over the past 20 years! Many Change Proposals adopted for MWL, with lots of new attributes

**Modality SCU needs to ask for these new attributes;
RIS SCP needs to provide them**

Type 3 ‘Optional’ does not mean ‘Ignore’!

Patient Name (0010,0010)

PN (person name) VR allows three component groups (nominally “alphabetic”, “ideographic”, “phonetic”)

Dealing with the increasingly important non-Western environments may require **multi-byte character sets**

- Unicode UTF-8, Chinese GBK 
- Character set for name is not necessarily same as for UI

And may require more robust name handling in apps

- With UTF-8, “alphabetic” is not a single byte per character
- Memory is cheap - allow full 64 characters per group
- Support localization for how RIS/HIS uses name groups

Patient ID (0010,0020)

But patients have more than one ID in the HIS/EHR

- Local MRN, national ID, insurance IDs

Which one is in Patient ID (0010,0020)?

- Use **Issuer of Patient ID (0010,0021)**
- Might also need to use **Issuer of Patient ID Qualifiers Sequence (0010,0024)** to be fully aligned with HL7v2 (CX Data Type) and IHE Cross-Enterprise Document Sharing (XDS)

Increasing requirements for all exchanged medical information to include the national or insurance ID

Use Other Patient IDs (0010,1000) or Other Patient IDs Sequence (0010,1002)

May need to move another value into Patient ID (0010,0020) upon export (e.g., to CD)

Be flexible!

- Different RIS/HIS will use these attributes differently in MWL
- Different localities will have different regulations for exported data

Many attributes support patient safety processes

- **SCU should be able to request all appropriate tags**

Pertinent Documents Sequence (0038,0100)

- **List of relevant patient medical documents (e.g., in HL7 CDA format)**
- **Retrieval through provided URL or DICOM C-MOVE**

Patient's Size Code Sequence (0010,1021)

- **Use with CID 7040 Broselow-Luten Pediatric Size Categories (Color Coding Kids™) for robust pediatric safety programme**

Color Coding Kids™



Color Coding Kids™
The Resuscitation-Life™ System

Resuscitation Medication Pocket Guide

PEDIATRIC

3 KG 4 KG 5 KG	PINK 6-7 KG	RED 8-9 KG	PURPLE 10-11 KG	YELLOW 12-14 KG	WHITE 15-18 KG	BLUE 19-23 KG	ORANGE 24-29 KG	GREEN 30-36 KG
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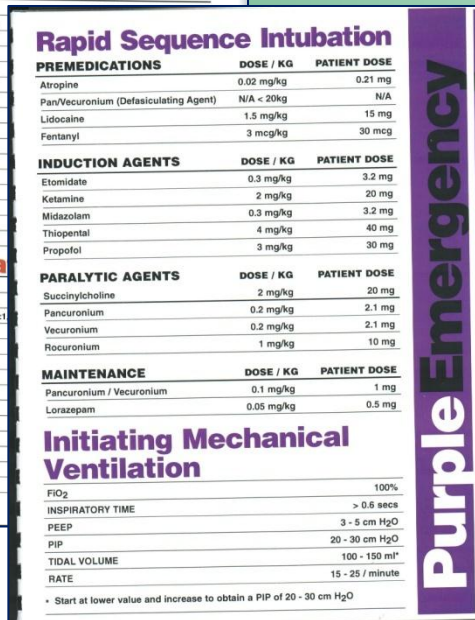
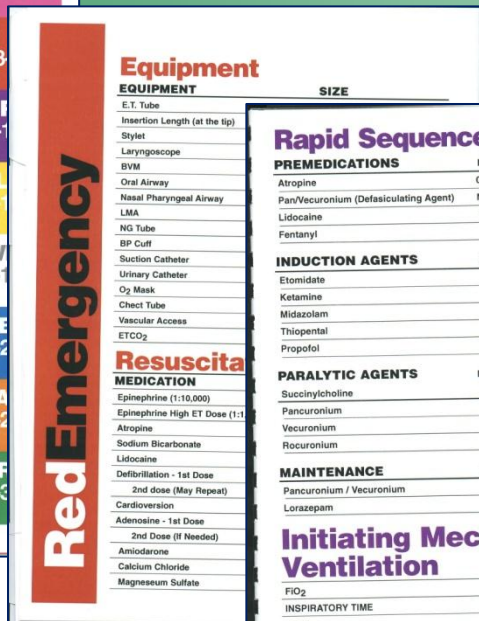
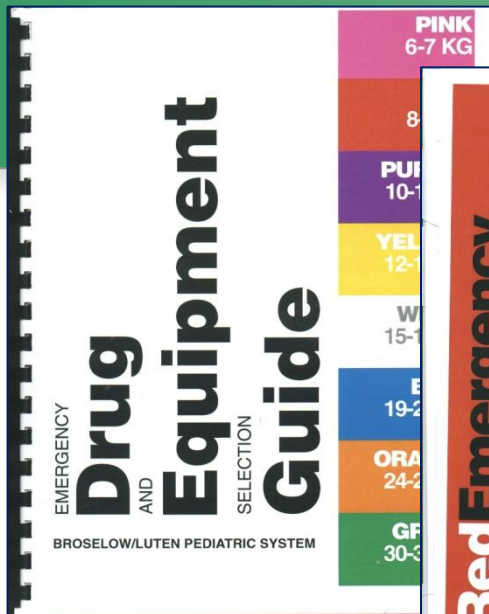
19-23 KG • BLUE

Broselow-Luten Pediatric Resuscitation Medication Pocket Guide

FIRST LINE DRUGS	DOSE
Adenosine	
3mg/mL	
<i>First Dose</i>	0.7mL
<i>Second Dose</i>	1.4mL
Amiodarone	
50mg/mL (Dilute with 42mL D5W)	2.1mL
Atropine	
0.1mg/mL*	
<i>First Dose</i>	4.2mL
<i>Second Dose</i>	4.2-5mL
Bicarbonate	
1mEq/mL	21mL
Epinephrine Standard	
0.1mg/mL(1:10,000)	2.1mL
Epinephrine High/ET	
1mg/mL(1:1,000)	2.1mL

*There are multiple concentrations of Atropine. Assure the 0.1mg/mL is used.

19-23 KG • Blue



B-L Concentration	PURPLE 10-11KG										Maintenance Fluids
#1											42 mLs/hr
Dopamine 1600 micrograms/mL											
mcg/kg/min	2	4	6	8	10	12	14	16	18	20	
	mcg	mcg	mcg	mcg	mcg	mcg	mcg	mcg	mcg	mcg	
mLs/hour	0.8	1.6	2.4	3.2	4	4.7	5.5	6.3	7	8	
	mL	mL	mL	mL	mL	mL	mL	mL	mL	mL	

Infusion bag label

Frush, D.P., et al., "Improved Pediatric Multidetector Body CT Using a Size-Based Color-Coded Format", AmJourRoent 2002
(<http://www.ajronline.org/cgi/content/full/178/3/721>)

“CONCLUSION ... This system provides an easy, expeditious, consistent, and preferable format for general pediatric body CT protocols. Most importantly, the color-coded system can reduce variations (errors) in the radiology department.”

Modalities and PACS increasingly operate in multi-institutional environment

Need explicit identification of institution (assigning authority) associated with orders and other IDs, aligned to HL7v2 HD Data Type

- Accession Number (0008,0050)
Issuer of Accession Number Sequence (0008,0051)
- Placer Order Number / Imaging Service Request (0040,2016)
Order Placer Identifier Sequence (0040,0026)
- Filler Order Number / Imaging Service Request (0040,2017)
Order Filler Identifier Sequence (0040,0027)
- Admission ID (0038,0010)
Issuer of Admission ID Sequence (0038,0014)

Some studies need to be associated with a healthcare process that extends over several visits

- Radiation oncology
- Image-guided therapy
- Pregnancy

Service Episode ID (0038,0060) can identify the extended process

Some acquisition is dependent on specific clinical data collected in a previous workflow step

- Acquisition directives, e.g., Japanese standard JJ1017
- Radiopharmaceutical infusion parameters for NM or PET

Protocol Context Sequence (0040,0440) conveys name:value pairs using controlled vocabulary

- Uses Content Item format similar to Structured Reporting
- Allows a single level of modifiers, also as Content Items

Modeled in MWL as part of the Scheduled Protocol Code Sequence (0040,0008)

- MWL request for Universal match (zero-length match key) on attribute will return its entire structure

Protocol Context Content Items – Part 16 Annex C

TID 15101
NM/PET Protocol Context
Type: Extensible Order: Significant

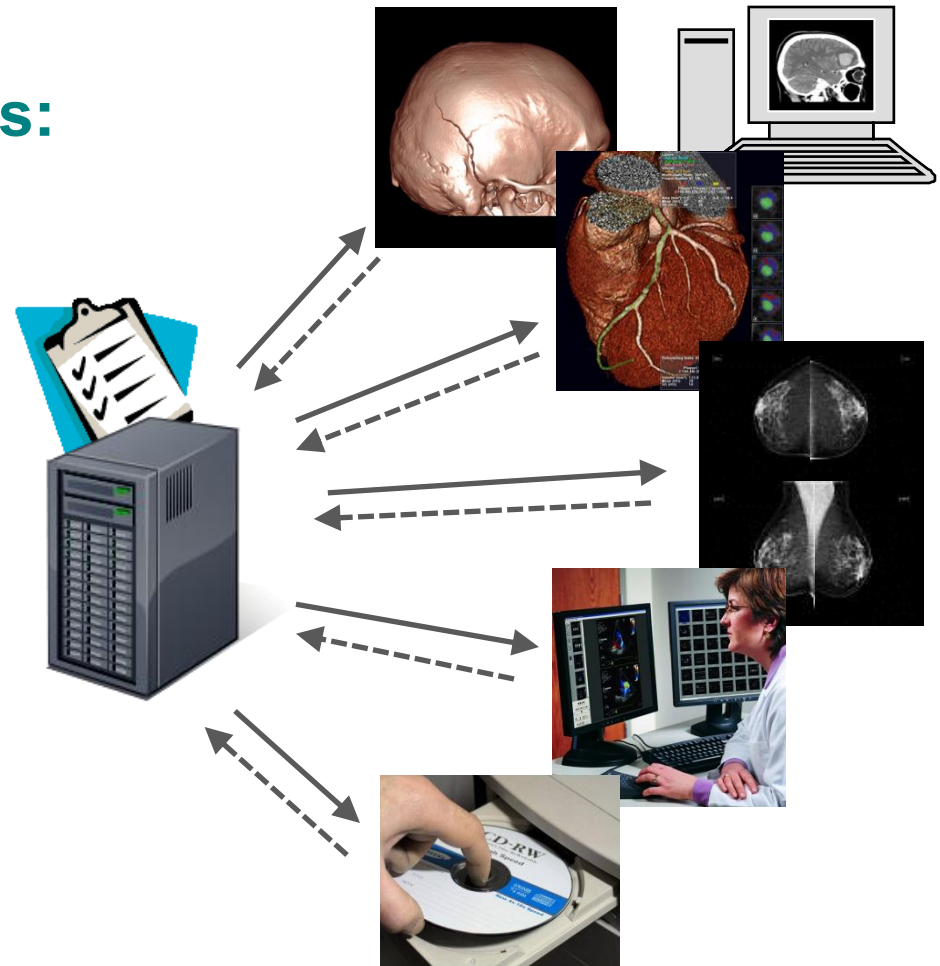
	NL	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1		CODE	EV (123001, DCM, "Radiopharmaceutical")	1	M		BCID 25 (NM) or 4021 (PET)
2	>	CODE	EV (C-B1000, SRT, "Diagnostic Radioisotope")	1	U		BCID 18 (NM) or 4020 (PET)
3	>	DATETIME	EV (123003, DCM, "Radiopharmaceutical Start Time")	1	U		
4	>	DATETIME	EV (123004, DCM, "Radiopharmaceutical Stop Time")	1	U		
5	>	NUMERIC	EV (123005, DCM, "Radiopharmaceutical Volume")	1	U		Units = DT(cm3, UCUM, "cm3")
6	>	NUMERIC	EV (123006, DCM, "Radionuclide Total Dose")	1	U		Units = DT(Bq, UCUM, "Bq")
7	>	NUMERIC	EV (123007, DCM, "Radiopharmaceutical Specific Activity")	1	U		Units = DT(Bq/mol, UCUM, "Bq/mol")
8	>	CODE	EV (G-C340, SRT, "Route of Administration")	1	U		BCID 11
9	>	NUMERIC	EV (123009, DCM, "Radionuclide Syringe")	1	U		Units = DT((counts)/s, UCUM "counts/s")

Unified Worklist and Procedure Step

UPS & IHE Post-Acquisition Workflow (PAWF)

Example “Workitem” Tasks:

- 3D View Generation
- Computer Aided Detection
- Clinical Applications
- Pre-fetching
- Image Routing
- CD Burning
- Image Importing
- ...



Add “Create Workitem” & “Push Workflow”

- Request another system to add item to worklist
- Replacement for implicit workflow (“push to a box and hope for the best”)

Simplify Implementation

- GPWL had N:M relation of SPS:PPS
- State diagram was very complex

Add “Cancel Request”

Improve Status/Result Monitoring

- Getting PPS feed was awkward;
required configuration and forwarding

UPS Workitem Structure

UPS Object

Relationship

Sched. Task Details

Progress

Perf. Task Details

A Workitem has its attributes grouped into 4 Modules:

(this does not affect processing;
just for logical organization)

UPS Workitem Structure

UPS Object

Relationship

Sched. Task Details

Progress

Perf. Task Details



Relationship Module

- Patient demographics
- Admission details
 - Order details
 - Requested Procedure
 - Accession #
 - Reason for Requested Procedure
 - Requesting physician/department
 - etc...

UPS Workitem Structure

UPS Object

Relationship

Sched. Task Details

Progress

Perf. Task Details



Scheduled Proc. Info. Module

- Priority
- Requested perform/completion time
- Requested resources/location
- Requested Procedure descrip./codes
- Requested Processing parameters
- List of Input data IDs & Location
- Input Data Availability Flag
- etc...

UPS Workitem Structure

UPS Object

Relationship

Sched. Task Details

Progress

Perf. Task Details



Progress Module

- UPS State (Scheduled, In-Progress, Completed, Canceled)
- Progress Status – Numerical (e.g. % complete)
- Progress Status – Description (e.g. Annealing phase complete)
- Contact information for performer (e.g. phone #)
- etc...

UPS Workitem Structure

UPS Object

Relationship

Sched. Task Details

Progress

Perf. Task Details



Performed Proc. Info. Module

- Time Performed/completed
- Performing resources/location
- Performed Procedure descrip./codes
- Performed Processing parameters
- List of Output data IDs & Location
- etc...

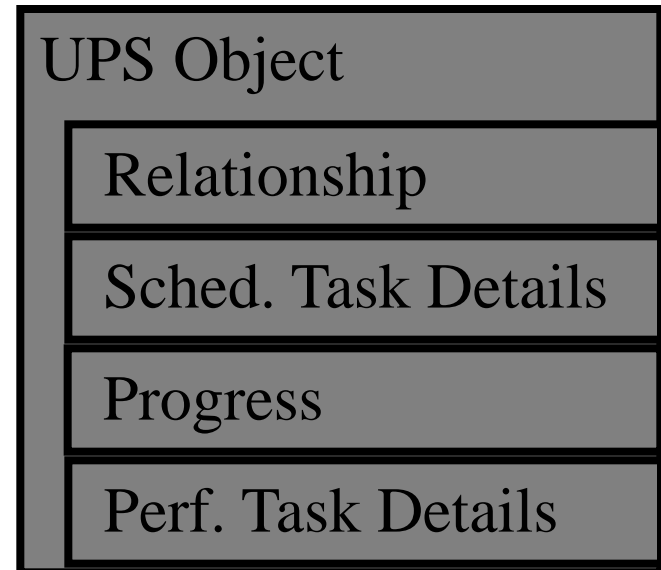
UPS SOP Classes

Each UPS Object is managed by a single SCP.

4 SOP Classes exist which can be used to operate on a UPS object.

Each SOP Class supports a few related operations.

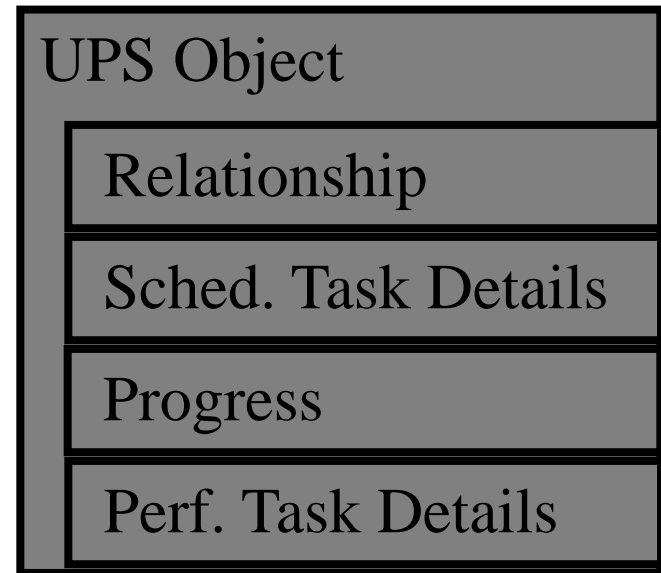
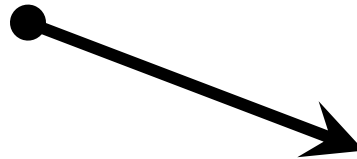
SCU/SCP not *required* to implement all the SOP Classes. Can implement SOP Classes based on the operations it needs.



UPS Push SOP Class

allows SCU systems to:

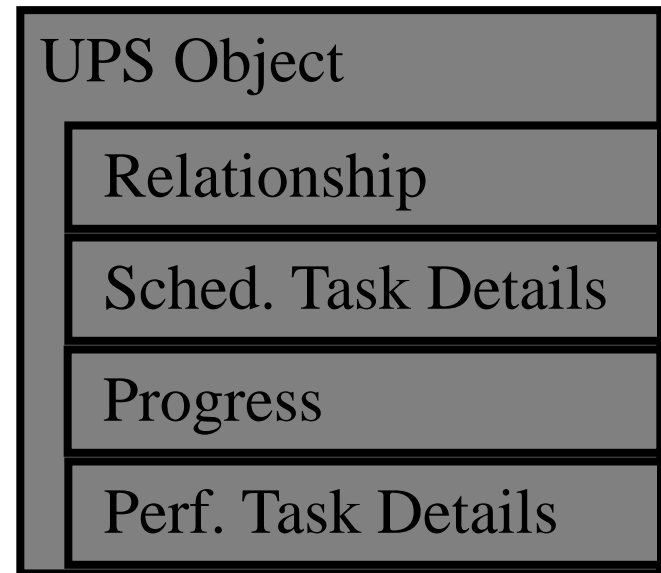
- * *create (push)* a new worklist item (i.e. instance) on a worklist
- * *request cancellation* of a worklist item



UPS Pull SOP Class

allows SCU systems to:

- * query a worklist for matching items
- * take ownership/control (pull) of a worklist item
- * modify progress/status/result details for the worklist item
- * finalize a controlled worklist item as Completed or Canceled.

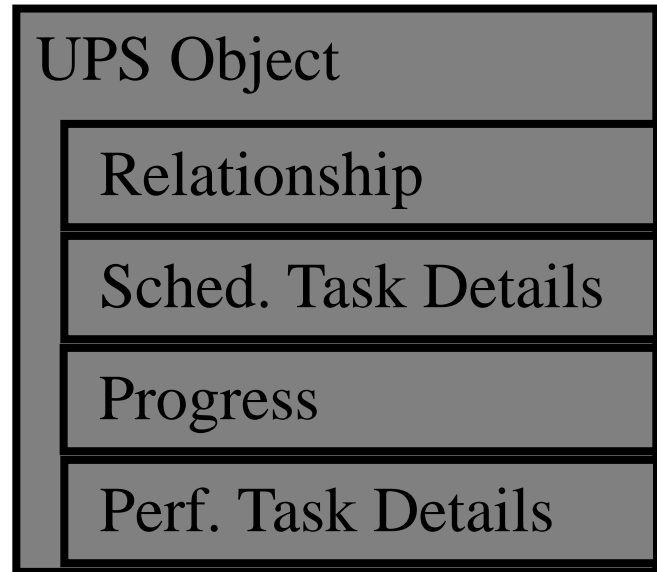


UPS Watch SOP Class



allows SCU systems to:

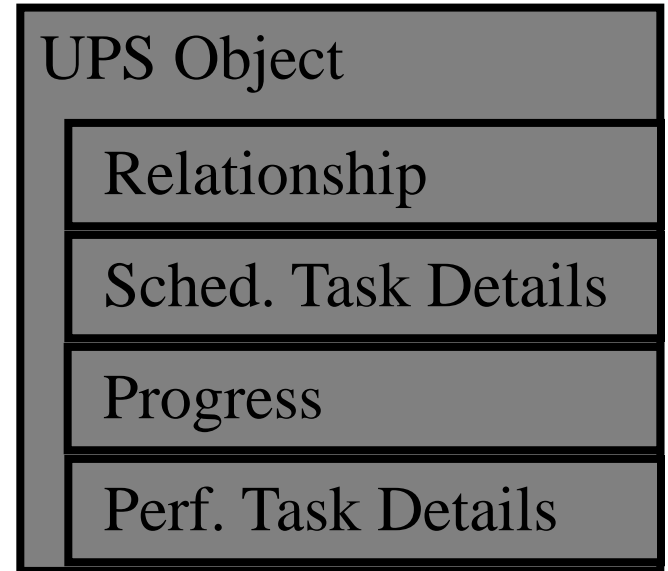
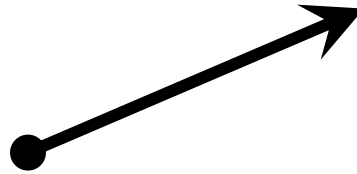
- * query a worklist for items of interest
- * subscribe/unsubscribe for change events for one worklist item
- * subscribe/unsubscribe for change events for all worklist items
- * get details for a worklist item
- * request cancellation of a worklist item



UPS Event SOP Class

allows SCU systems to:

* receive change events for worklist items

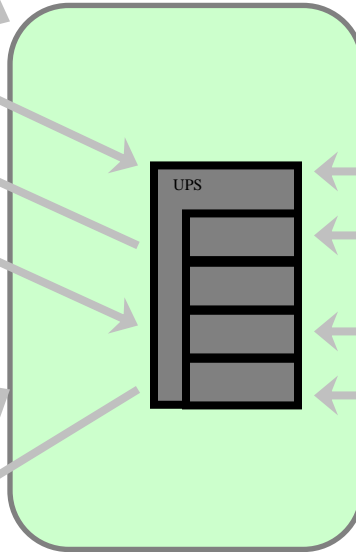


UPS Pull Workflow

Requester
(SCU)



Worklist
Manager
(SCP)



Performer
(SCU)

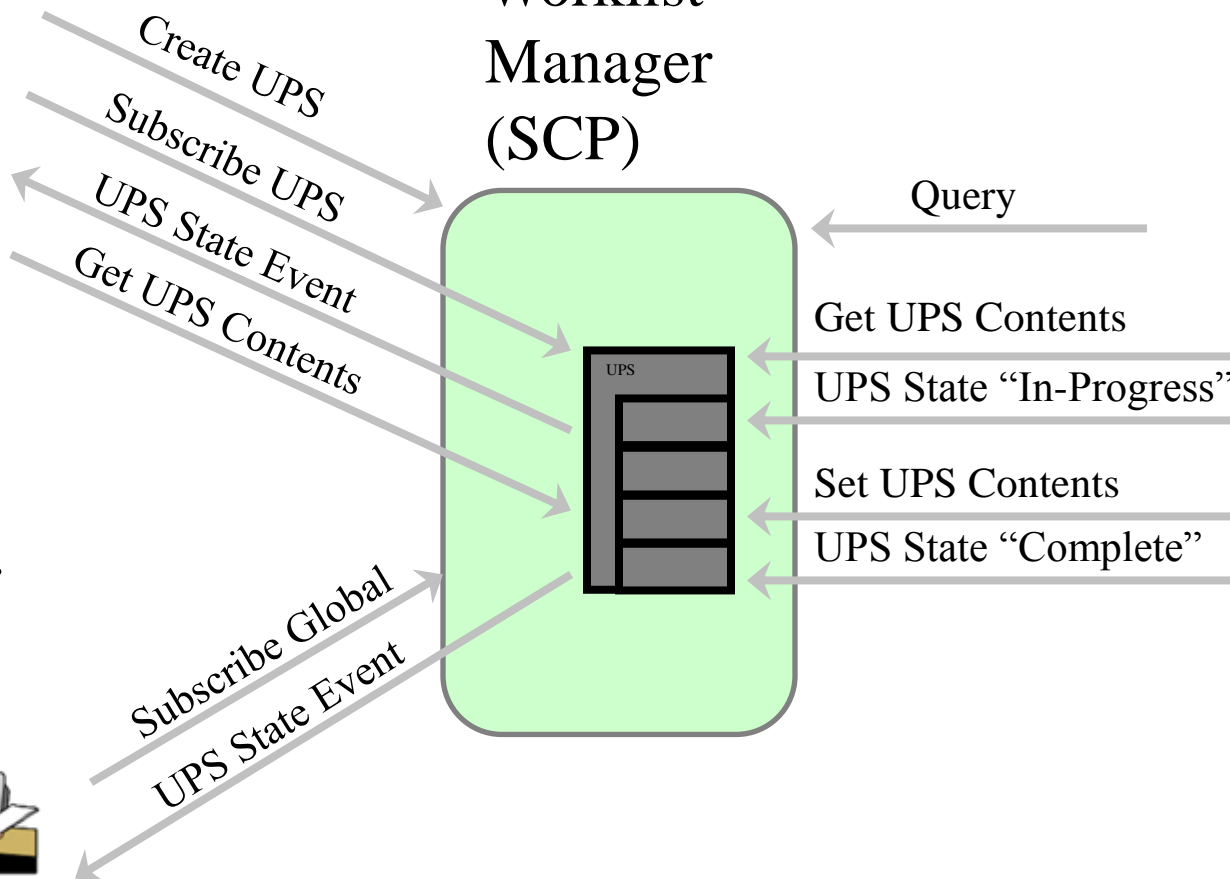


3D Workstation

Watcher
(SCU)



**Dashboard
System**

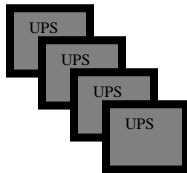


Pull Workflow

SCP



RIS



SCU



3D Workstation

← Give me a list of tasks that need to be done
(C-FIND)

← I will do that one
(N-ACTION Set to IN-PROGRESS)

← Record these details in the UPS
(N-SET attribute values)

← I am finished
(N-ACTION Set to COMPLETE)

Push Workflow

SCU



RIS

SCP



3D Workstation



Please perform this task
(N-CREATE with these attribute values) →

Notify me about progress for that task
(N-ACTION Subscribe) →

← I have started to do that task
(N-EVENT it is IN-PROGRESS)

← I have updated details in the UPS
(N-EVENT)

← I am finished
(N-EVENT it is COMPLETE)

→ Give me the result details of the task
(N-GET these attribute values)

No central controller

- Workstation watches flow of N-EVENTs: “System A did X”, “System B did Y”
- Workstation decides “Hmmm, I think I will do this”
- Workstation internally creates a UPS
- Interested Subscribers are notified of Workstation activity via N-EVENT; N-GET details as needed

Examples:

- CAD workstation sees N-EVENT that Mammo Acq. is complete; decides to do CAD processing
- Reporting station sees N-EVENT that CAD is complete; decides to queue reading worklist for that study

Reliable Watcher (SCU)

- **Problem: SCP might delete a completed UPS before SCU gets needed details**
- **(e.g. due to Network latency or outage)**
- **Missing a UPS could prevent Watcher from:**
 - monitoring completion
 - extracting details
 - creating subsequent UPS Instances,
 - referencing UPS 1 outputs as UPS 2 inputs

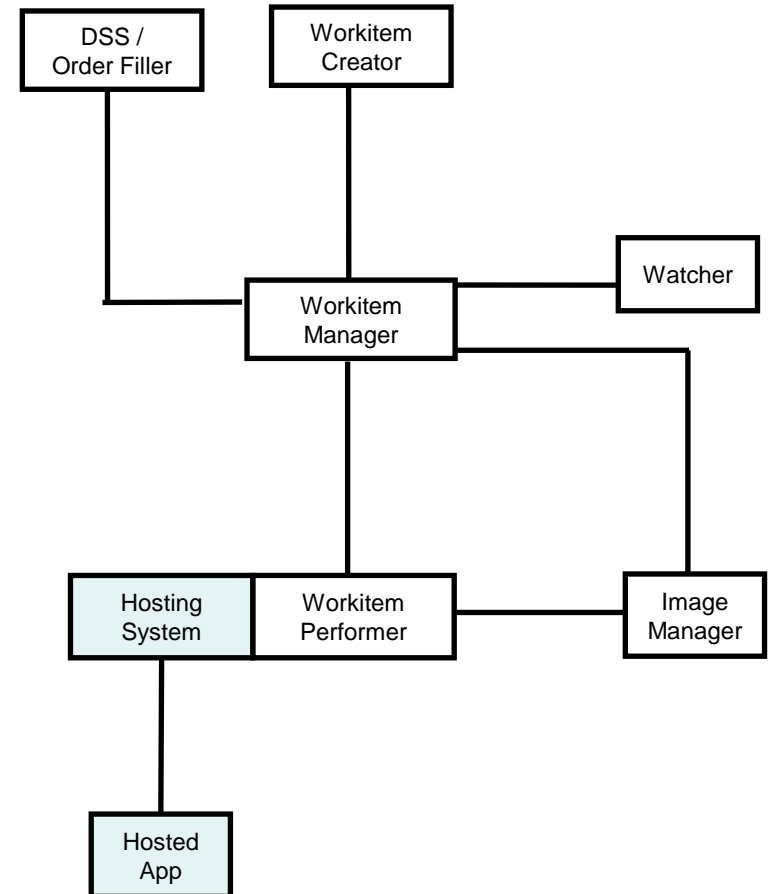
Mechanism

- **SCU Sets a Deletion Lock flag during subscription**
- **SCP can't delete UPS with outstanding Deletion Locks**
- **SCU removes Deletion Lock after retrieving final state of UPS**
- **SCP free to delete UPS after all deletion locks removed**
- **SCP documents how it handles orphans**

Post-Acquisition Workflow

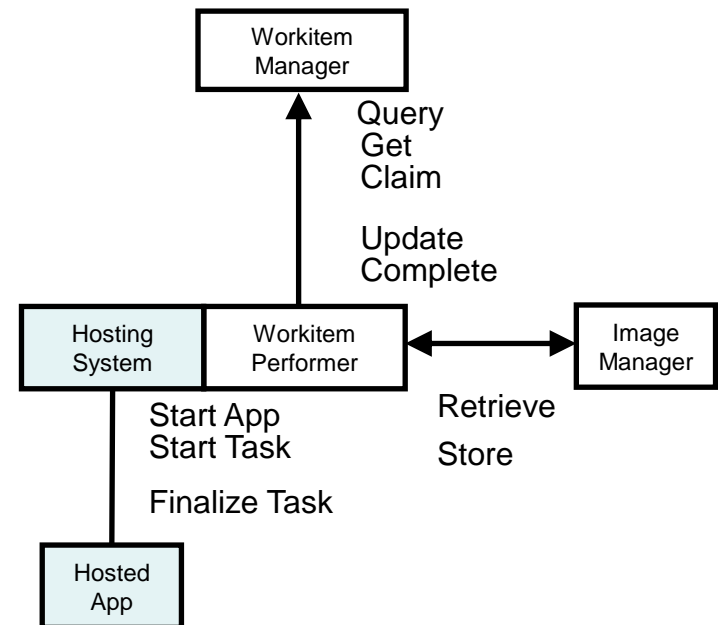
Essential Profile Features:

- **Worklist managed processing**
 - Automated & manual
- **Progress notifications**
 - Any interested system (RIS, Billing, Reading Worklist, Dashboard, Analytics)
 - Subscription-based
- **Cancelation requests**
 - With reason & contact
- **Hosted applications (“DICOM plugins”)**



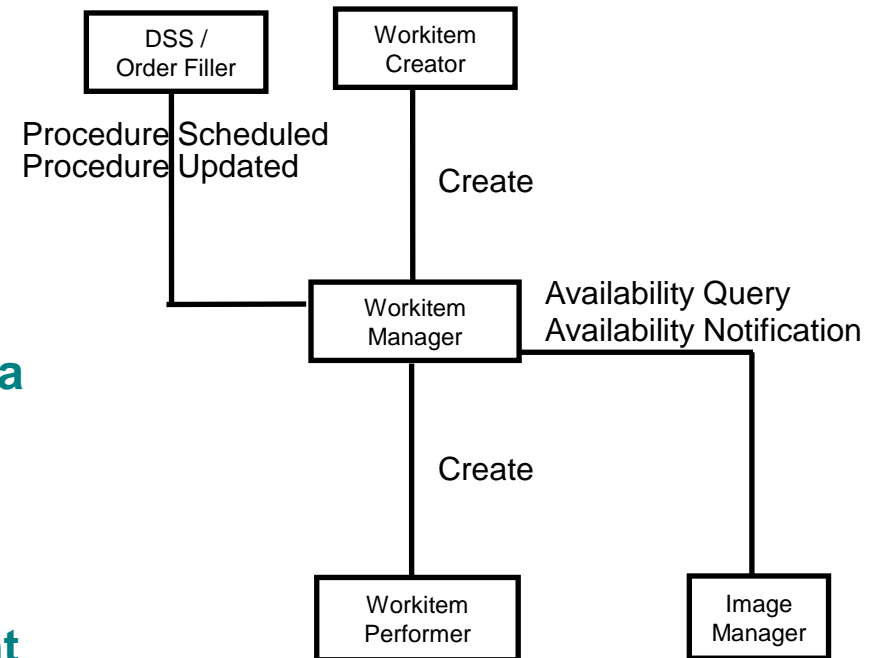
Perform UPS Workitems

- **Typical Pull Workflow**
 - Query, Claim, Update, Complete
- **Input / Output References**
 - Local to Performer;
Local Image Manager;
Other Image Manager
- **Hosted applications (plugins)**
 - Performer may choose to be a Hosting System
 - Apps may be 3rd party



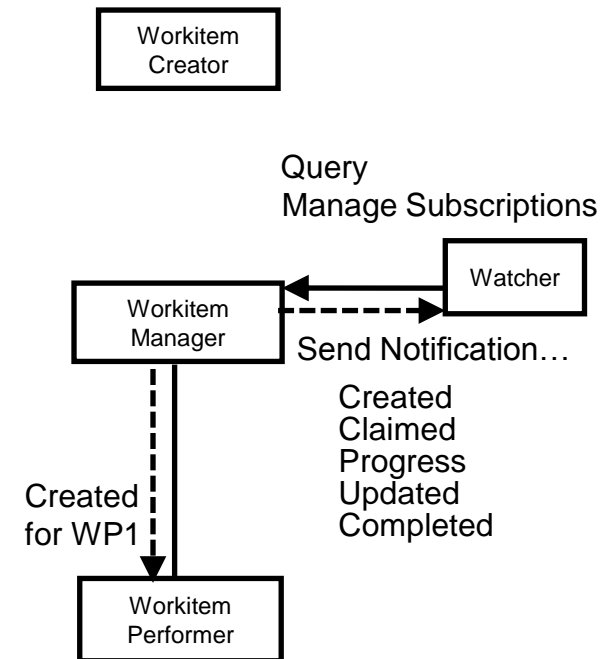
Create UPS Workitems

- **By Workitem Manager**
 - Internal logic
 - Triggered by DSS/Order Filler scheduling
 - Triggered by Image Manager Data
- **By Workitem Creator**
 - Explicit create request
 - Can be grouped with any relevant system
- **By Workitem Performer**
 - Explicit create request
 - “Unscheduled”/Self-scheduled/Ad Hoc



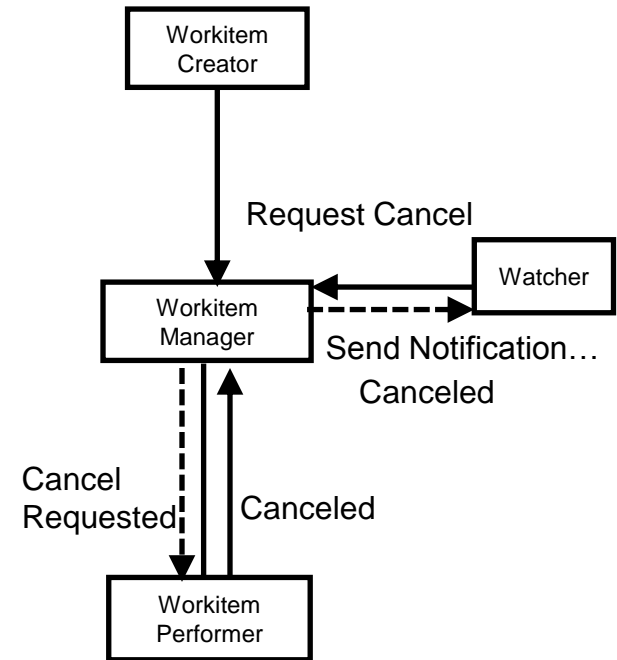
Monitor UPS Workitems

- **Subscribe / Unsubscribe**
 - Globally or for Individual Workitems
- **Applications/Usage**
 - Schedule subsequent tasks
 - Report progress
 - Bill for performed tasks
 - Populate reading worklist
 - Drive dashboard
 - Analyze dept. performance
 - Claim assigned workitems



Cancel UPS Workitems

- **Workitem Manager**
 - Can directly cancel unclaimed workitems
 - Otherwise notifies Performer
- **Workitem Performer**
 - Cancels at its own discretion
- **Watcher**
 - Waits for Notification task was either Completed or Canceled



Use cases will drive configuration parameters

- Names of worklists managed by worklist manager
- Codes for work tasks
- Object types to be provided as input and as output

Use case driven specification of use of standards is *profiling*, and it is critical for effective use of UPS

- First example is Radiotherapy, DICOM Part 17 Annex BBB

MWL has evolved – and new attributes are critical for patient safety

- **Type 3 doesn't mean “ignore”**

UPS is the new service for post-acquisition workflows

- **Supports a variety of push and pull workflows, in accordance with Profiles**

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Thank you for your attention !