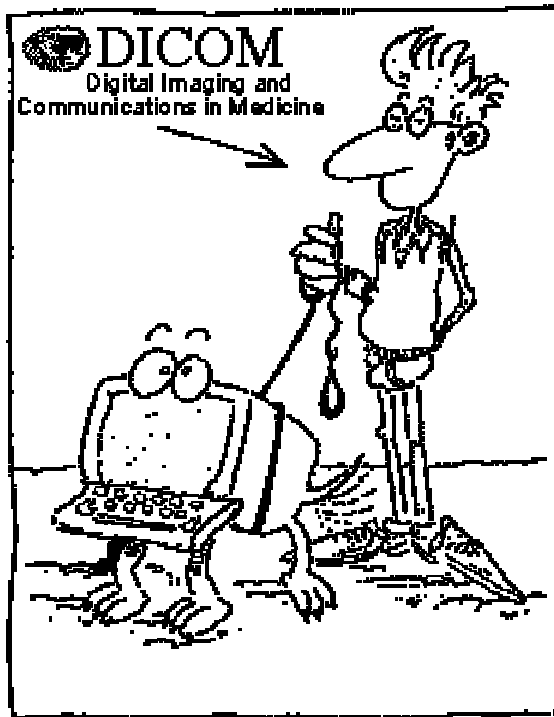# *Radiotherapy Perspectives of DICOM*

Michael Neumann

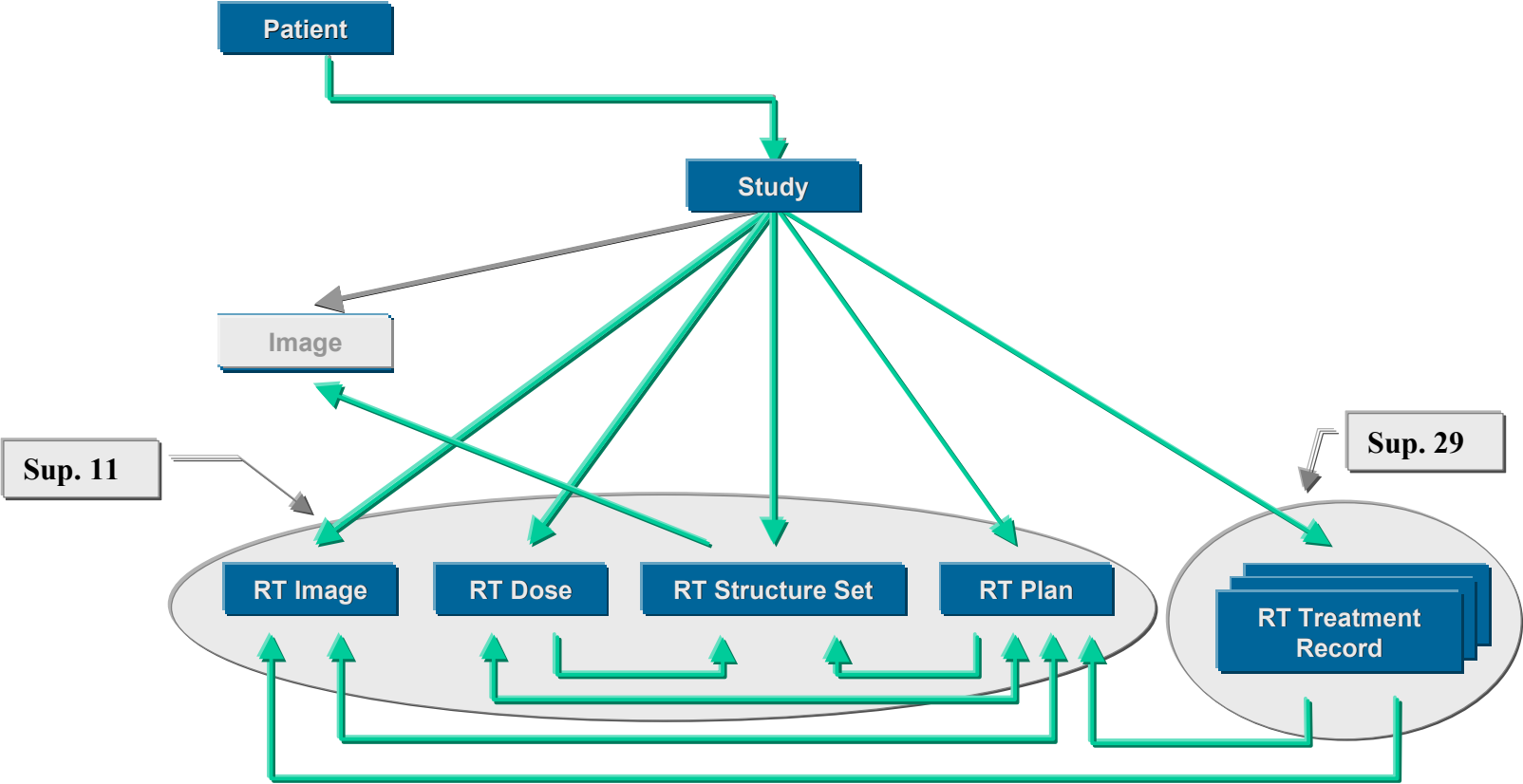*Nucletron B.V., Germany*

Contents

- Current Status of RT Support
  - Linking, Approval, Dynamic Objects, Query/Retrieve

- Current Developments
  - Support Intensity Fluence Map in RT Plan
  - Extended Query / Retrieve for RT Objects
 - Modified General Purpose Worklist SOP Class

- Integration with RO Information Systems

Object References

Plan Relationship

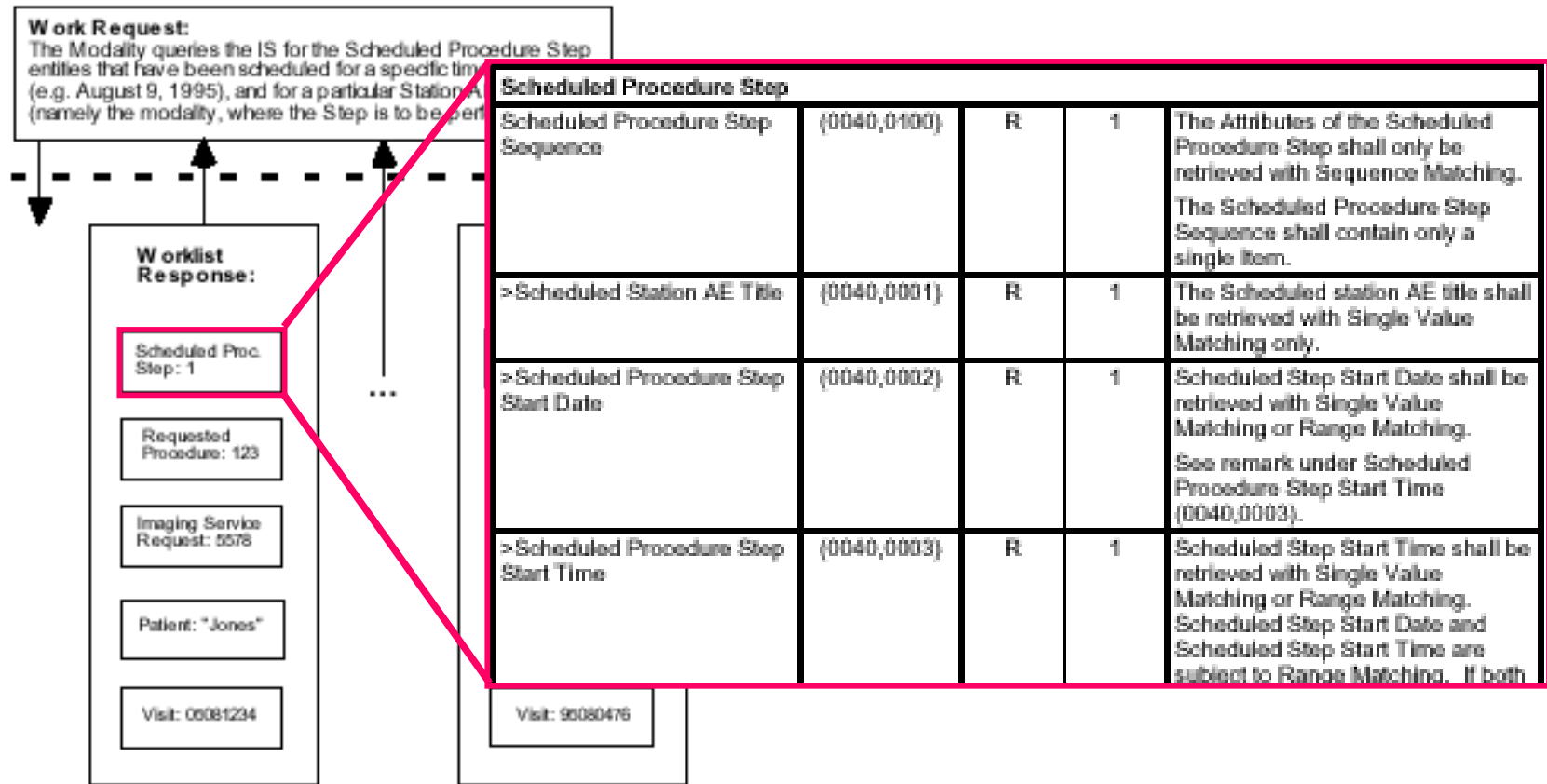|			
Referenced RT Plan Sequence	(300C,0002)	3	Introduces sequence of related SOP Class/Instance pairs describing related instances of RT Plan. One or more items may be included in this sequence.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if Referenced RT Plan Sequence (300C,0002) is sent.
>Referenced SOP Instance UID	(0008,1155)	1C	Uniquely identifies the referenced SOP Instance. Required if Referenced RT Plan Sequence (300C,0002) is sent.
>RT Plan Relationship	(300A,0055)	1C	Relationship of referenced plan with respect to current plan. Required if Referenced RT Plan Sequence (300C,0002) is sent. Defined Terms: PRIOR = plan delivered prior to current treatment ALTERNATIVE = alternative plan prepared for current treatment PREDECESSOR = plan used in derivation of current plan
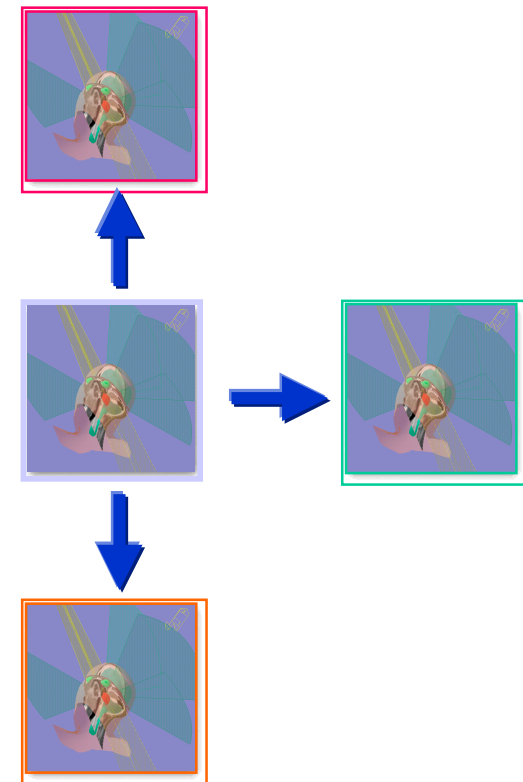
Radiotherapy Data is dynamic
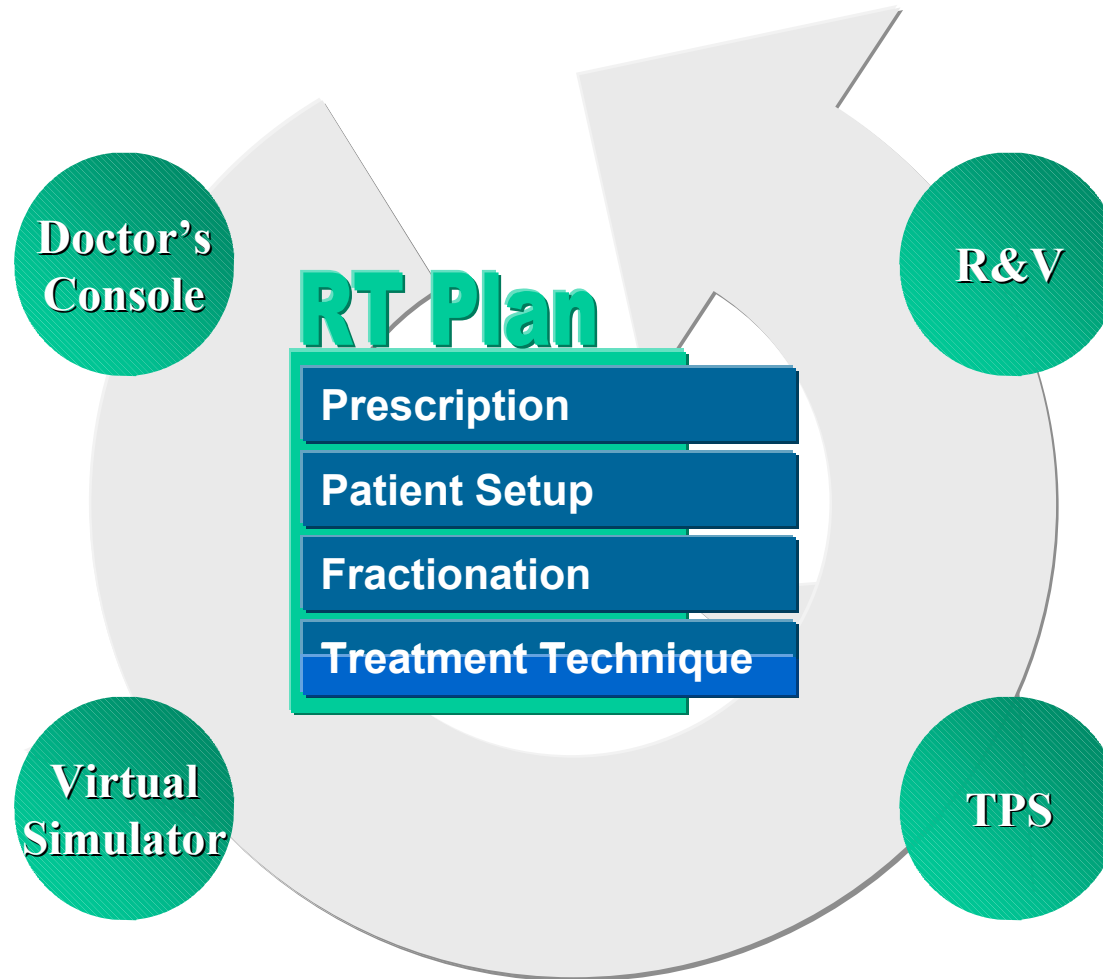
Approval Status

C.8.8.16 **Approval Module**

Table C.8-48—APPROVAL MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Approval Status	(300E,0002)	1	Approval status at the time the SOP Instance was created. Enumerated Values: APPROVED = Reviewer recorded that object met an implied criterion UNAPPROVED = No review of object has been recorded REJECTED = Reviewer recorded that object failed to meet an implied criterion
Review Date	(300E,0004)	2C	Date on which object was reviewed. Required if Approval Status (300E,0002) is APPROVED or REJECTED.
Review Time	(300E,0005)	2C	Time at which object was reviewed. Required if Approval Status (300E,0002) is APPROVED or REJECTED.
Reviewer Name	(300E,0008)	2C	Name of person who reviewed object. Required if Approval Status (300E,0002) is APPROVED or REJECTED.

Modality Worklist SOP Class

Work Request:
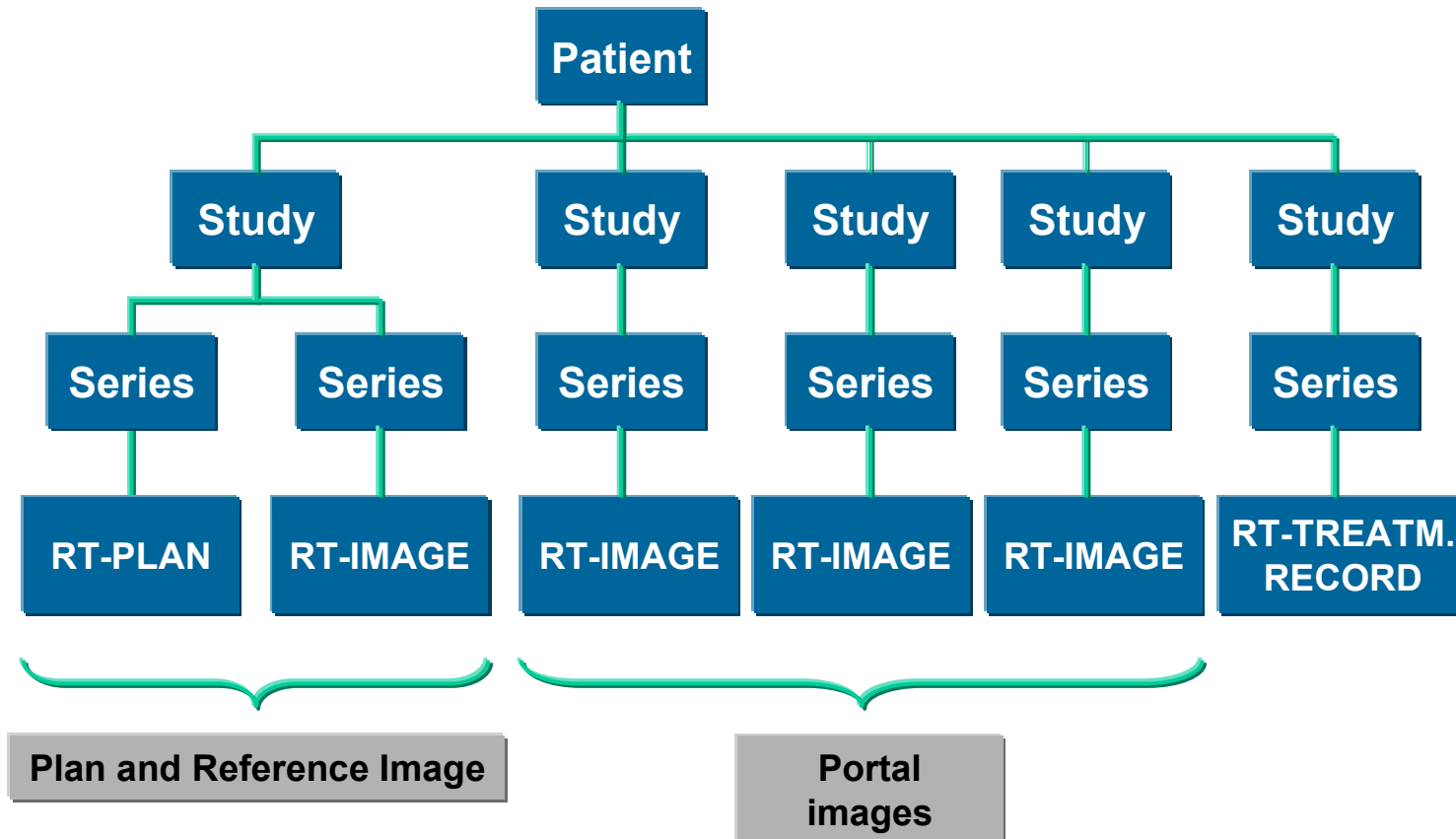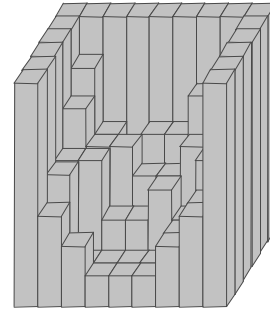The Modality queries the IS for the Scheduled Procedure Step entities that have been scheduled for a specific time (e.g. August 9, 1995), and for a particular Station (namely the modality, where the Step is to be perf...

Worklist Response:

Scheduled Proc. Step: 1

Requested Procedure: 123

Imaging Service Request: 5578

Patient: "Jones"

Visit: 06081234

...

Visit: 96080476

Scheduled Procedure Step					
Scheduled Procedure Step Sequence	(0040,0100)	R	1	The Attributes of the Scheduled Procedure Step shall only be retrieved with Sequence Matching. The Scheduled Procedure Step Sequence shall contain only a single Item.	
>Scheduled Station AE Title	(0040,0001)	R	1	The Scheduled station AE title shall be retrieved with Single Value Matching only.	
>Scheduled Procedure Step Start Date	(0040,0002)	R	1	Scheduled Step Start Date shall be retrieved with Single Value Matching or Range Matching. See remark under Scheduled Procedure Step Start Time (0040,0003).	
>Scheduled Procedure Step Start Time	(0040,0003)	R	1	Scheduled Step Start Time shall be retrieved with Single Value Matching or Range Matching. Scheduled Step Start Date and Scheduled Step Start Time are subject to Range Matching. If both	

Modality Worklist SOP Class

Work Request:
The Modality queries the IS for the Scheduled Procedure Step entities that have been scheduled for a specific time period (e.g. August 9, 1995), and for a particular Station AE Title (namely the modality, where the Step is to be performed.)

Modality

Worklist Response:

Scheduled Proc. Step: 1

Requested Procedure: 123

Imaging Service Request: 5578

– Copy the following Attribute values from the Modality Worklist information into the Image SOP Instances and into the related MPPS SOP Instance:
   – Study Instance UID
   – Referenced Study Sequence
   – Accession Number
   – Requested Procedure ID
   – Scheduled Procedure Step ID
   – Scheduled Procedure Step Description
   – Scheduled Action Item Code Sequence

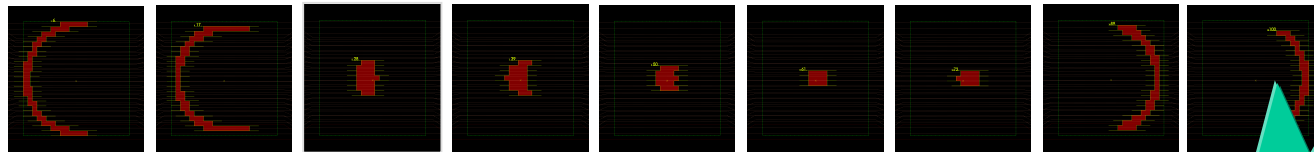| Requested Procedure				
Requested Procedure ID	(0040,1001)	O	1	
Requested Procedure Description	(0032,1060)	O	1C	The Requested Procedure Description (0032,1060) or the Requested Procedure Code Sequence (0032,1064) or both present.
>Coding Scheme Version	(0008,0103)	O	3	
>Code Meaning	(0008,0104)	O	3	
Study Instance UID	(0020,000D)	O	1	
Referenced Study Sequence	(0008,1110)	O	2	
>Referenced SOP Class UID	(0008,1150)	O	1C	Required if a Sequence Item is present.
		O	1C	Required if a Sequence Item is present.
		O	2	
		O	2	

(Un-) Structured Data

IMRT Treatment Techniques
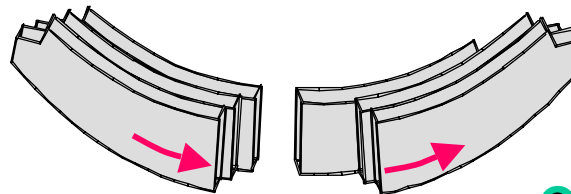
- Compensators

Compensator Matrix ✓
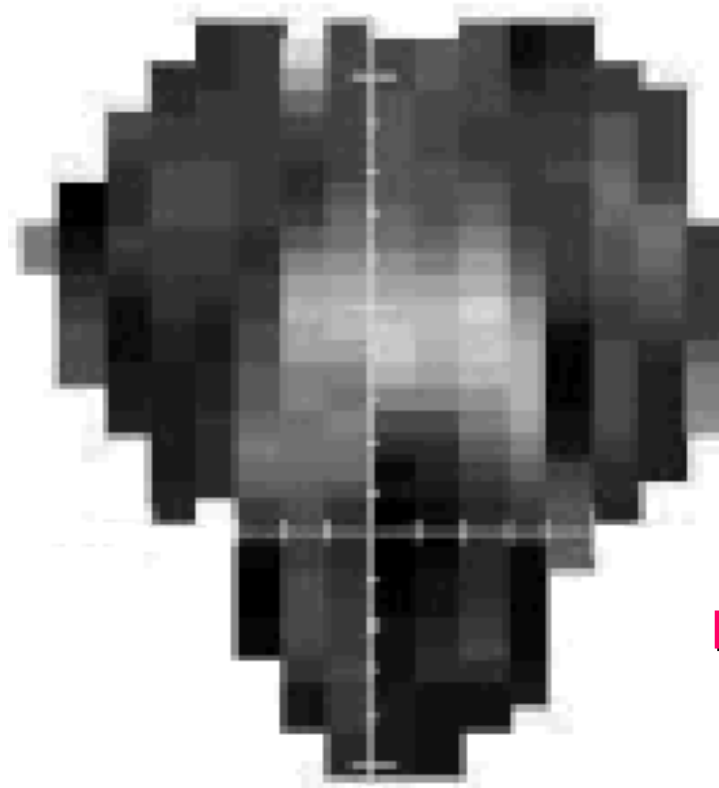
- Step & Shoot MLC

Control Points ✓

- Dynamic MLC

Control Points ✓

IMRT Treatment Techniques

- Intensity Fluence Map

Extended Beams Module

Query/Retrieve

C.6.1.1.5   Composite object instance Level

Table C.6-4 defines the keys at the Composite object instance information level of the Patient Root Query/Retrieve information Model.

Table C.6-4

COMPOSITE OBJECT INSTANCE LEVEL KEYS FOR THE PATIENT ROOT QUERY/RETRIEVE INFORMATION MODEL

Description	Tag	Type
Instance Number	(0020,0013)	R
Overlay Number	(0020,0022)	O
Curve Number	(0020,0024)	O
LUT Number	(0020,0026)	O
SOP Instance UID	(0008,0018)	U
All Other Attributes at composite object instance Level		O

Extended Query/Retrieve

Optimization

- Limit Doses (PTV and OaR)
- Over- / Underdose volume fraction (PTV und OaR)
- Constraint Weights

- Dose Calculation Grid
- Calculation Algorithm
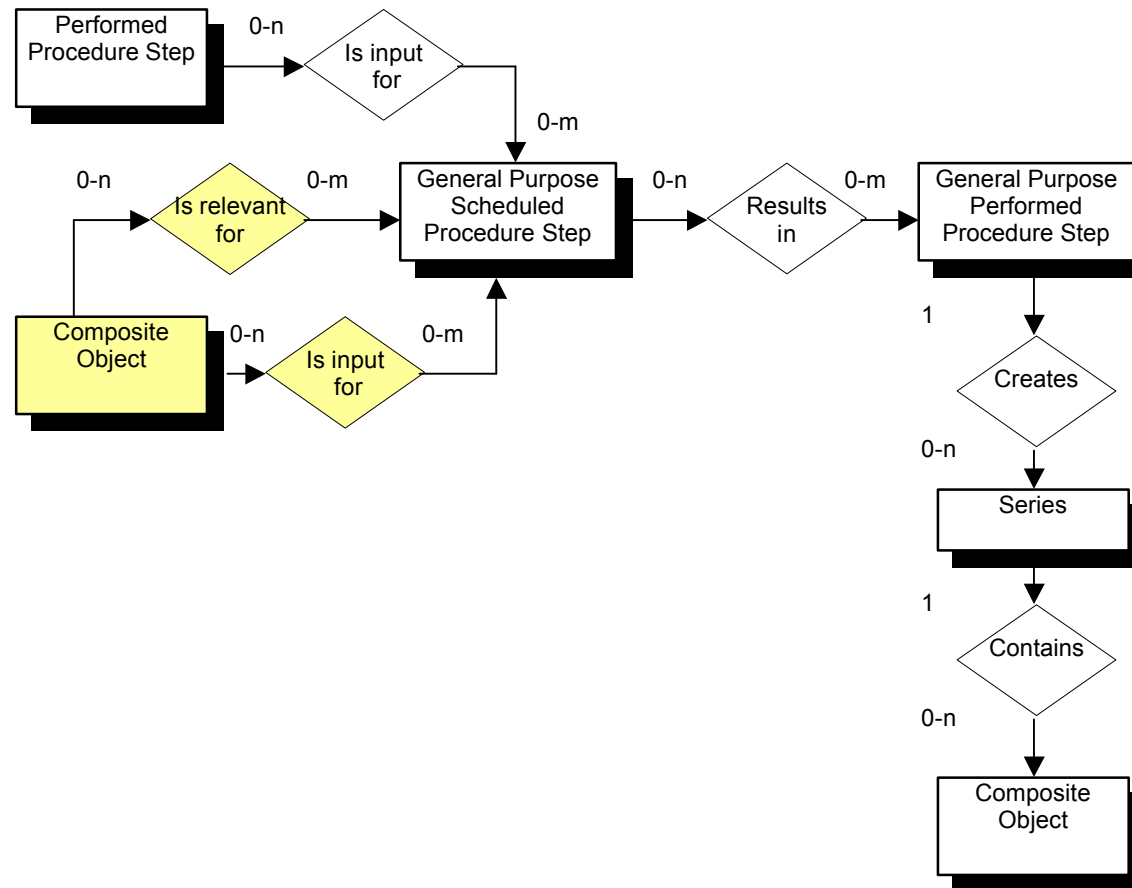- Density Correction
- Other Constraints

Prescription Module ✔
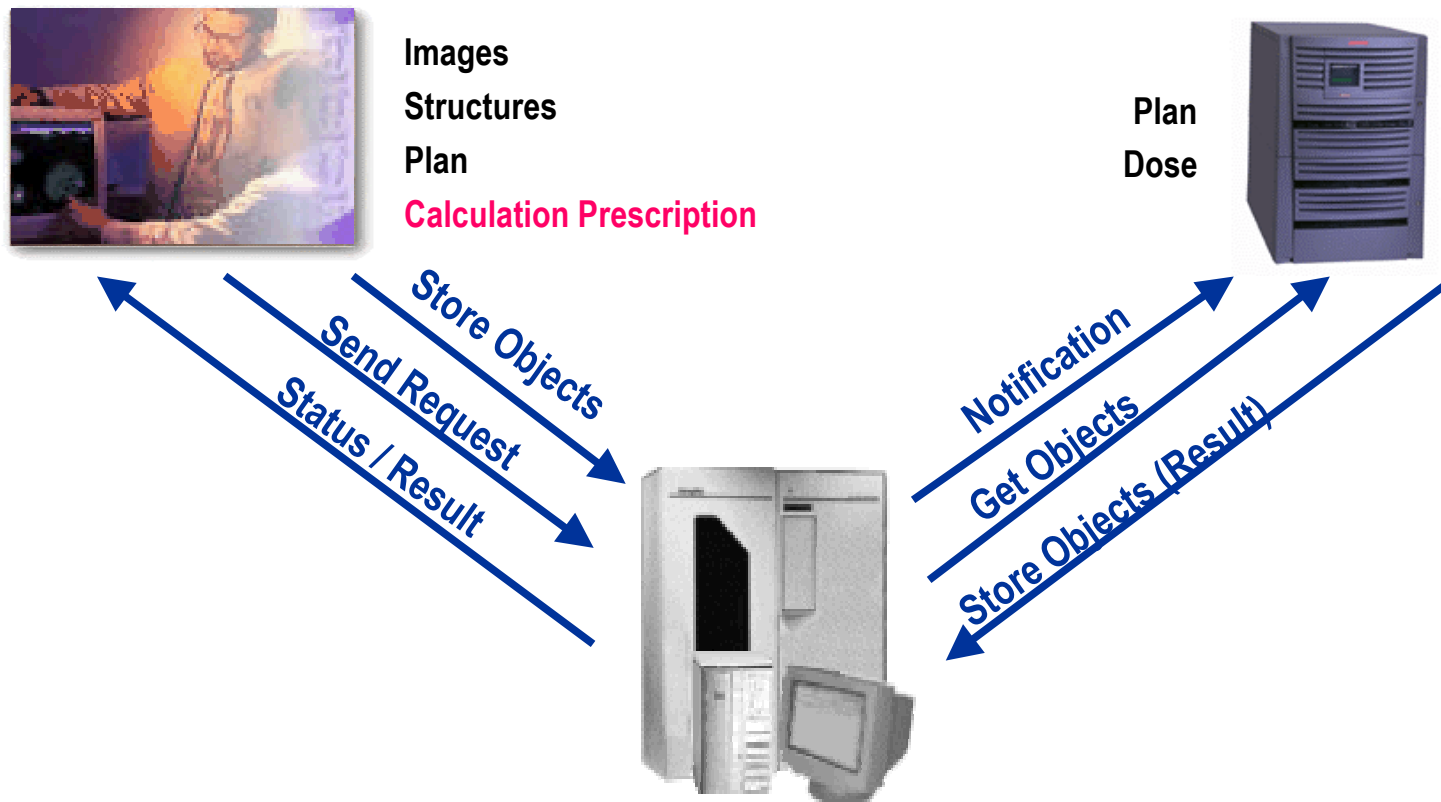
General Purpose Worklist (?)
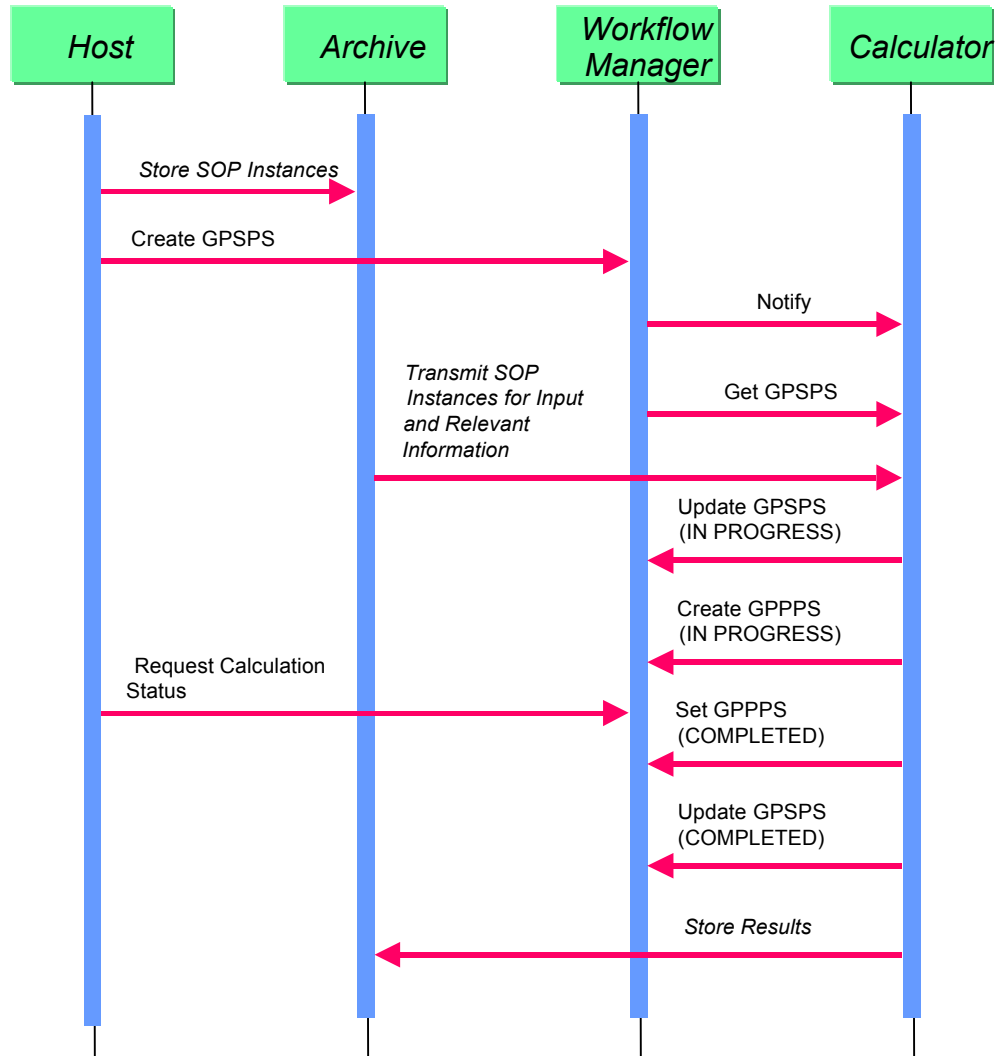
General Purpose Worklist

- Supplement 52

General Purpose Worklist

- Order-Placement, e.g. Dose Calculation
  - Supplement 74

Images
Structures
Plan
Calculation Prescription

Plan
Dose

Store Objects

Send Request

Status / Result

Notification

Get Objects

Store Objects (Result)

General Purpose Worklist

Access Control
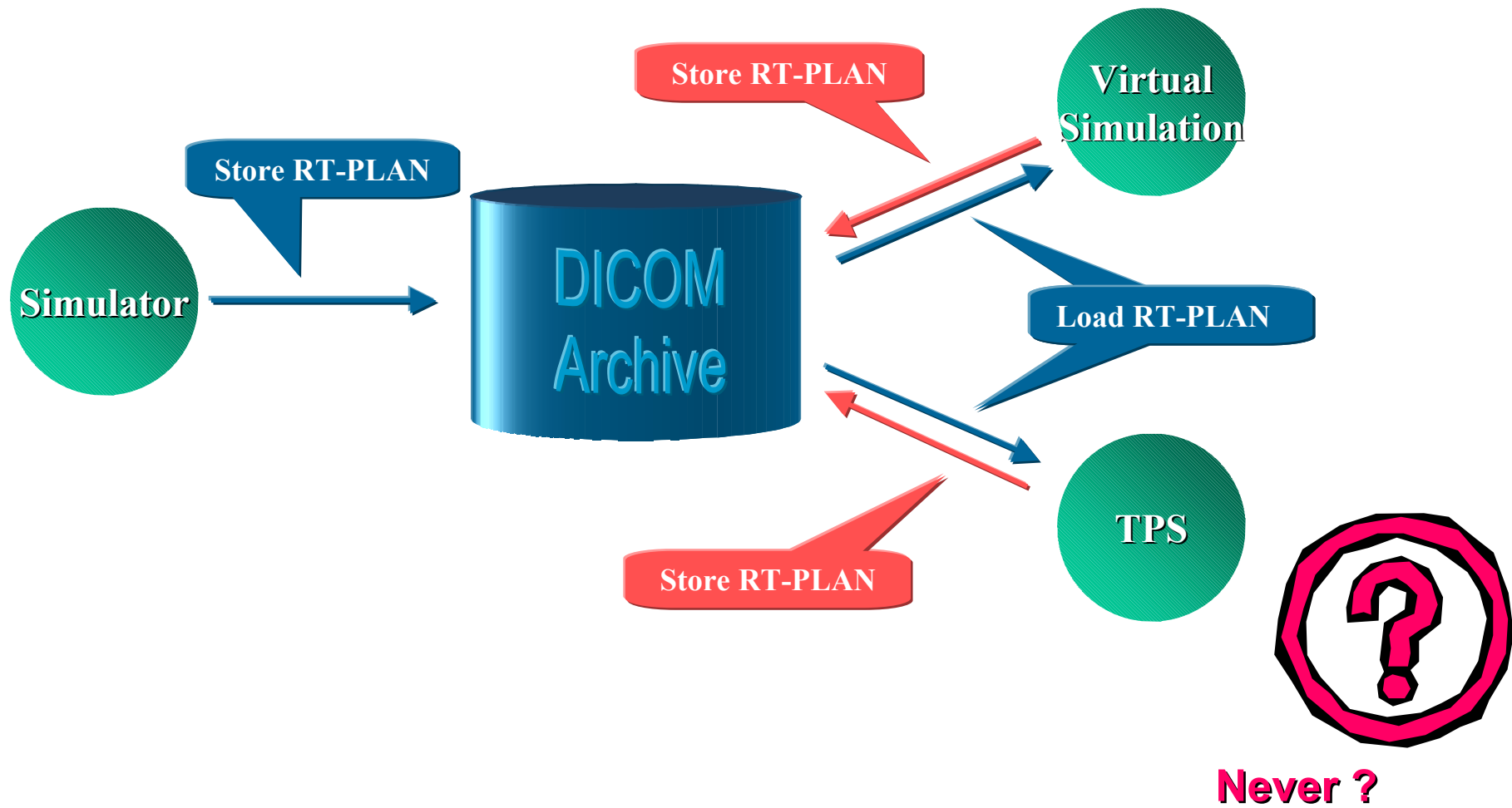
Current Developments

- Extended Query/Retrieve
  - RT Query/Retrieve SOP Class Profile

- General Purpose Worklist
  - Supplement 74 (Extend Supplement 52)

- Functional Changes
  - Fluence Matrix, Optimization Parameters, (Proton Therapy)

- Change Proposals

Radiology Workflow at a glance

- Driven by events generated in the Radiology Information System (RIS)

- Typically:
  - Doctor requests one or more examinations
  - Examinations are performed according to a prescribed procedure
  - Images are archived
  - Images are analyzed and findings are reported
  - Doctor receives report for each of requested examination

What can DICOM offer to facilitate this workflow ??

DICOM Image Information Management

- Defined to facilitate the communication between Information System (IS), Picture Archive and Communication System (PACS) and Modalities.

- Three key SOP Classes defined:
  - Modality Worklist Management (MWL)
  - Modality Performed Procedure Step (MPPS)
  - Storage Commitment

- Specified to work independently, but also specified to work together and thereby support workflow and system integration.

Modality Worklist

- MWL enables modality integration with information system's managed data

- Prepare imaging procedure by including patient, scheduling and medical data
  - Patient Name/ID, procedure date/time, procedure codes, Accession Number

- MWL is "one way trip" (i.e IS -> Modality)

- Enables DICOM Images to contain HIS/RIS/RTIS data

IS -> Modality connection

- Modality requests Worklist from IS

IS

Event:
"Start new working day."

Request
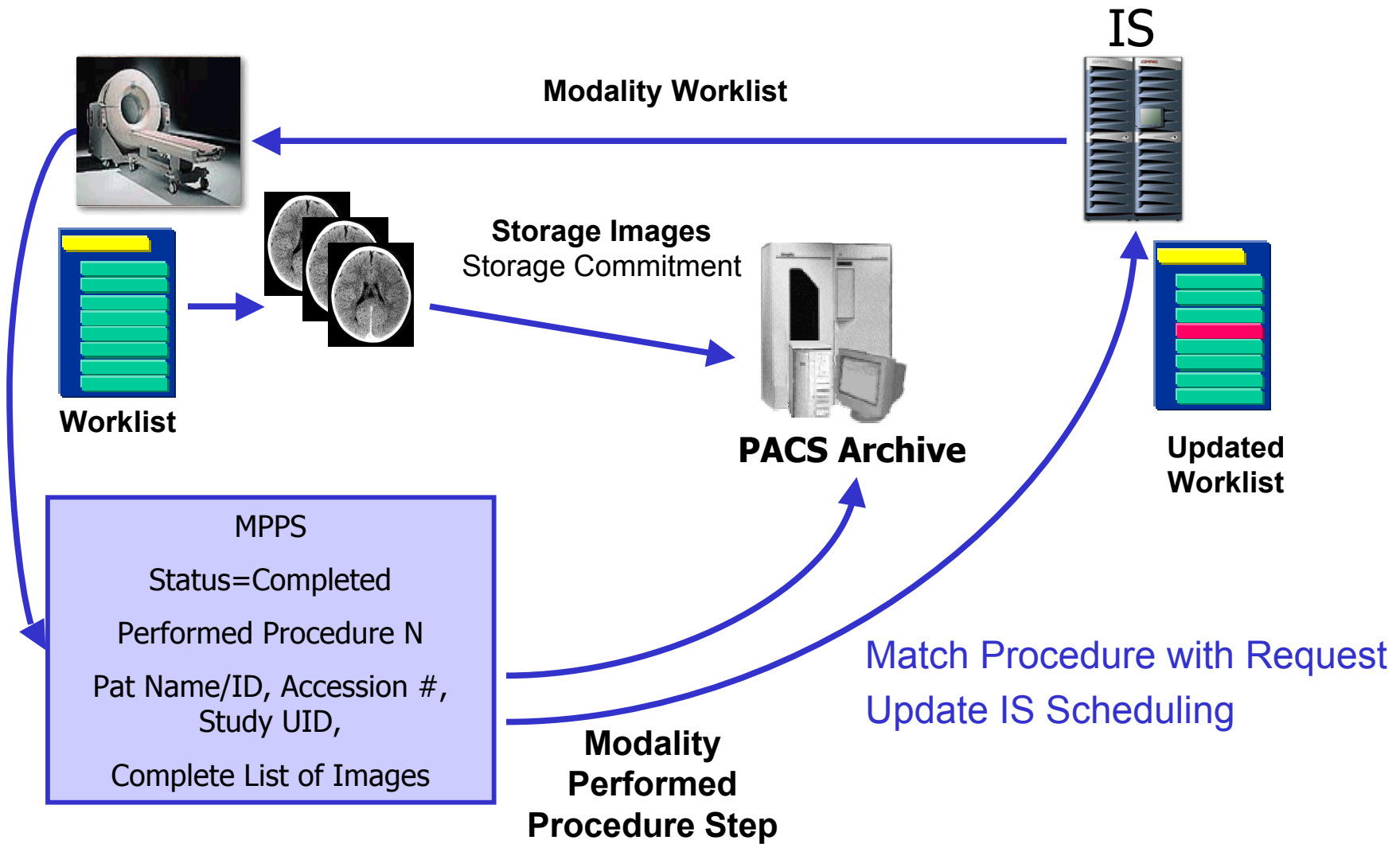
Worklist

"Select Patients."
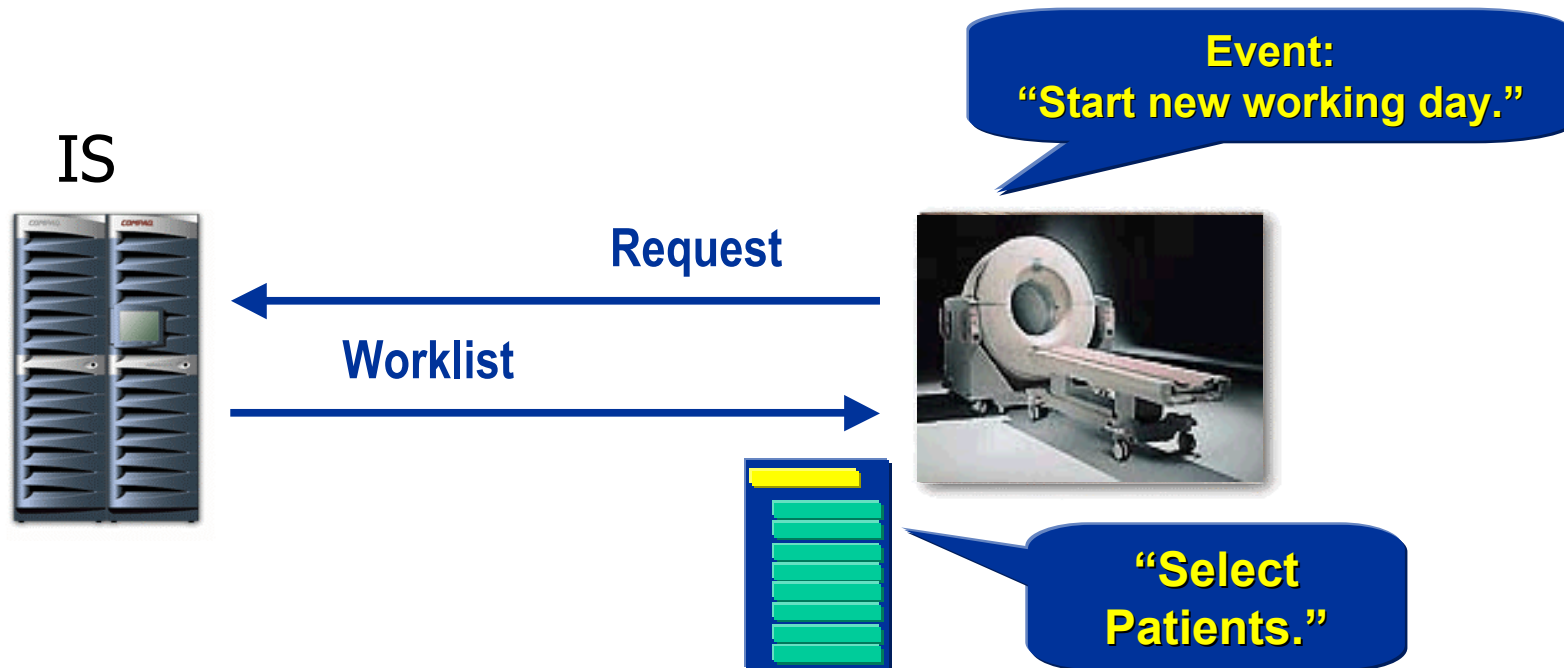
Modality Performed Procedure Step

- Conveys details about procedures step(s) performed

- Conveys detailed statuses such as "IN PROGRESS", "COMPLETED" and "DISCONTINUED"

- Provides "return trip" feedback such as:
  - Scheduled information obtained via MWL
  - What, when, and how was the procedure performed
  - Accession Number, Patient Name/ID, procedure step codes, radiation dose values, …..
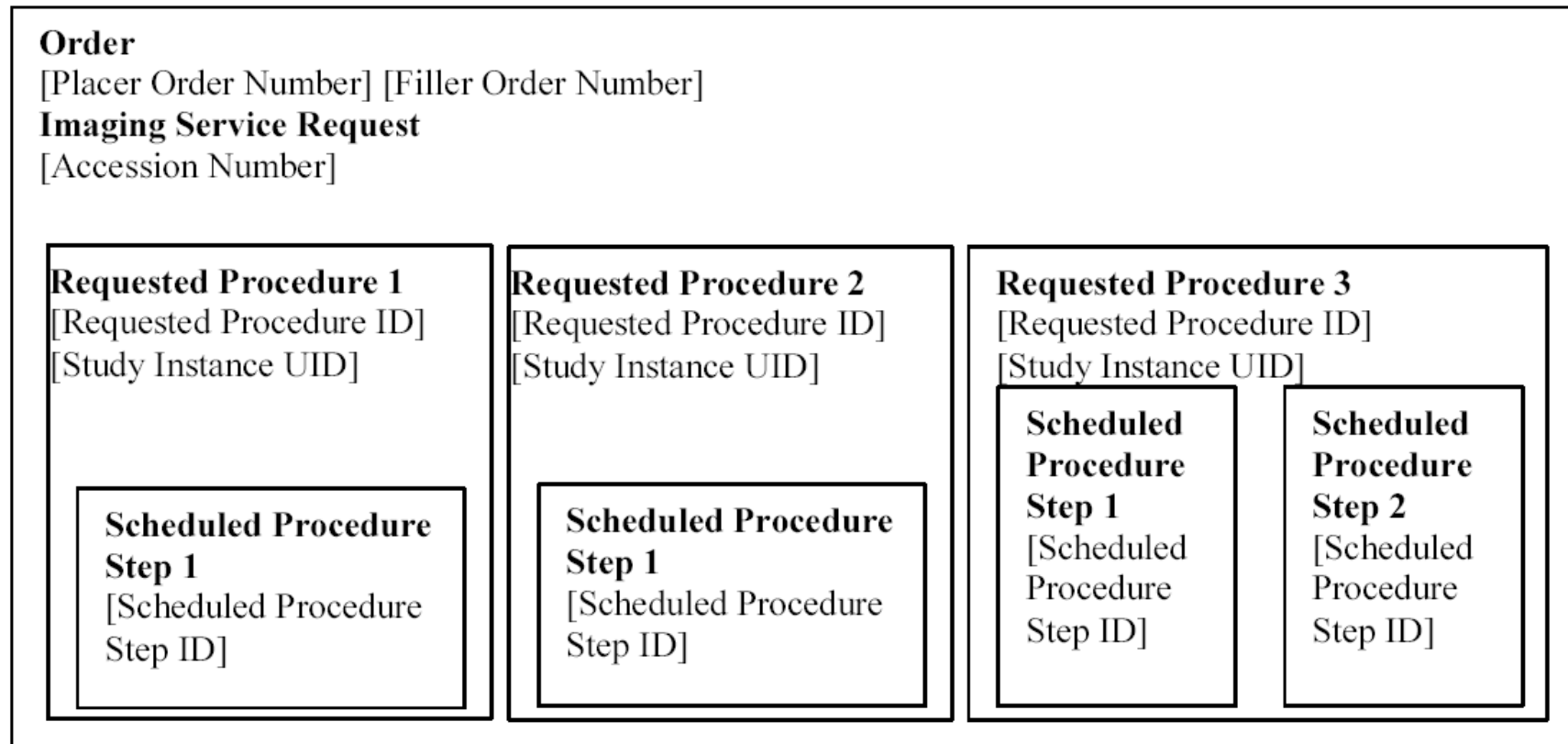 - List of images acquired, Study Instance UID, ….

Storage Commitment

- Modalities obtain explicit agreement from storage device that objects are reliably stored

- The duration of storage is defined by the storage device product

- Facilitates automated or simplified deletion of images on modalities

- Avoids accidental deletion of images on modalities

Integration flow example

IS

Modality Worklist

Worklist

Storage Images
Storage Commitment

PACS Archive

Updated
Worklist

MPPS

Status=Completed

Performed Procedure N

Pat Name/ID, Accession #,
Study UID,

Complete List of Images

Modality
Performed
Procedure Step

Match Procedure with Request
Update IS Scheduling

Accession Number / Requested Procedure ID

Order
[Placer Order Number] [Filler Order Number]
Imaging Service Request
[Accession Number]

Requested Procedure 1	**Requested Procedure 2**	**Requested Procedure 3**
[Requested Procedure ID]	[Requested Procedure ID]	[Requested Procedure ID]
[Study Instance UID]	[Study Instance UID]	[Study Instance UID]

Scheduled Procedure Step 1
[Scheduled Procedure Step ID]

Scheduled Procedure Step 1
[Scheduled Procedure Step ID]

Scheduled Procedure Step 1
[Scheduled Procedure Step ID]

Scheduled Procedure Step 2
[Scheduled Procedure Step ID]

A.1-1 Hierarchy of Components of an Order

IHE Technical Framework – Integration Profiles Rev. 5.5, April 2003

# Workflow and IS integration

- Accession Number is used in multiple ways:
  - An Imaging Service Request
  - A group of Requested Procedures in an order
  - A Requested Procedure

- DICOM standardises Accession Number to be a "user visible" identifier for an Imaging Service Request

- Requested Procedure ID is the "user visible" identifier for a requested procedure.

DICOM – Key Identifiers
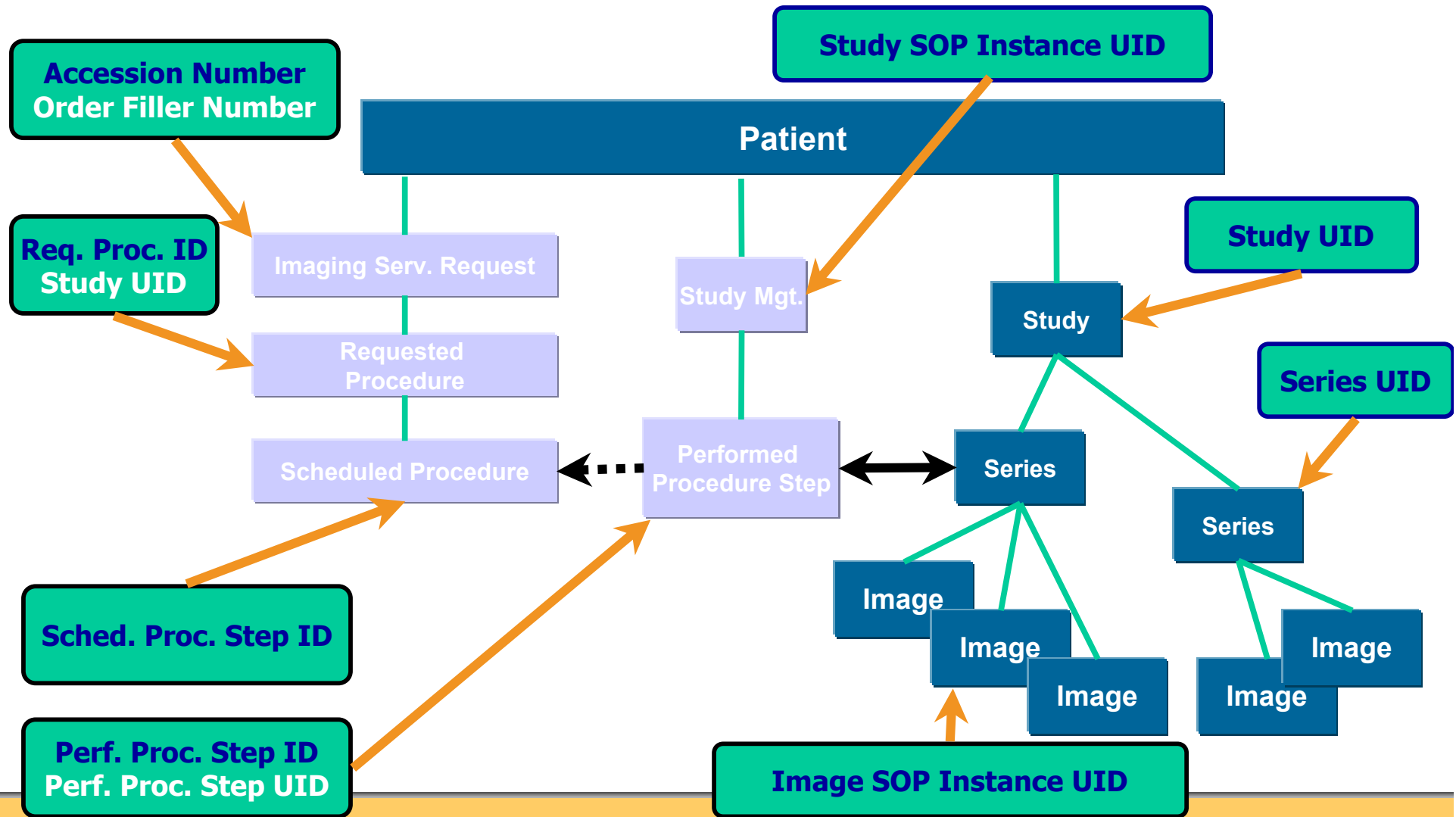
(H/R/RT)IS has limited DICOM support

- Installation of a DICOM BROKER
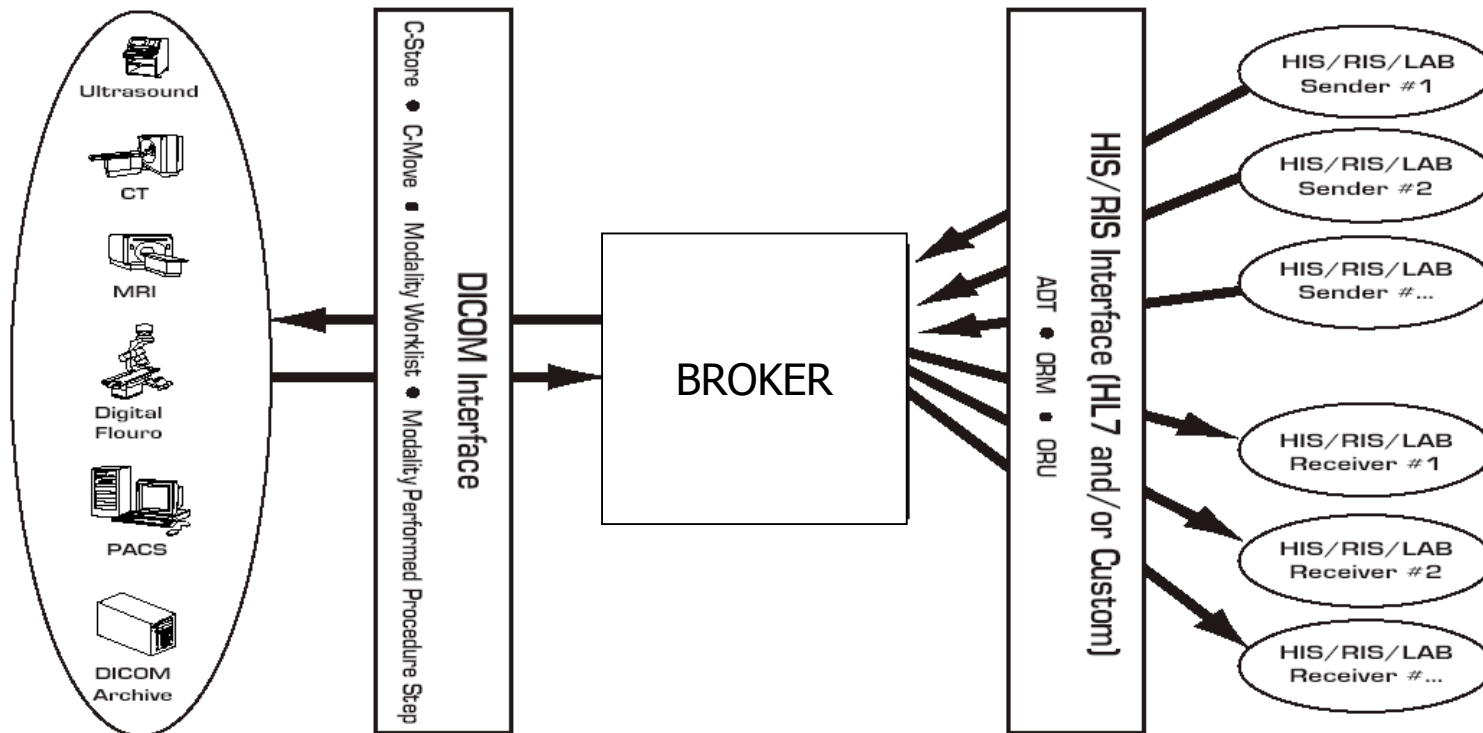
Workflow Support in RT

- Generally no Basic Worklist Management support

- No support for Modality Performed Procedure Step IOD

- Accession Number not commonly used

- Extended Worklist Management required
  - Supplement 74
  - Composite Objects are
    - Input
    - Relevant

… this will be the next step that the RT vendors have to take.

Thank you for your attention.
Questions ?

Special thanks to
Karsten Eilertsen
DNR Oslo, Norway