

Digital Imaging Communications in Medicine

DICOM in a Nutshell

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ICS - ARC



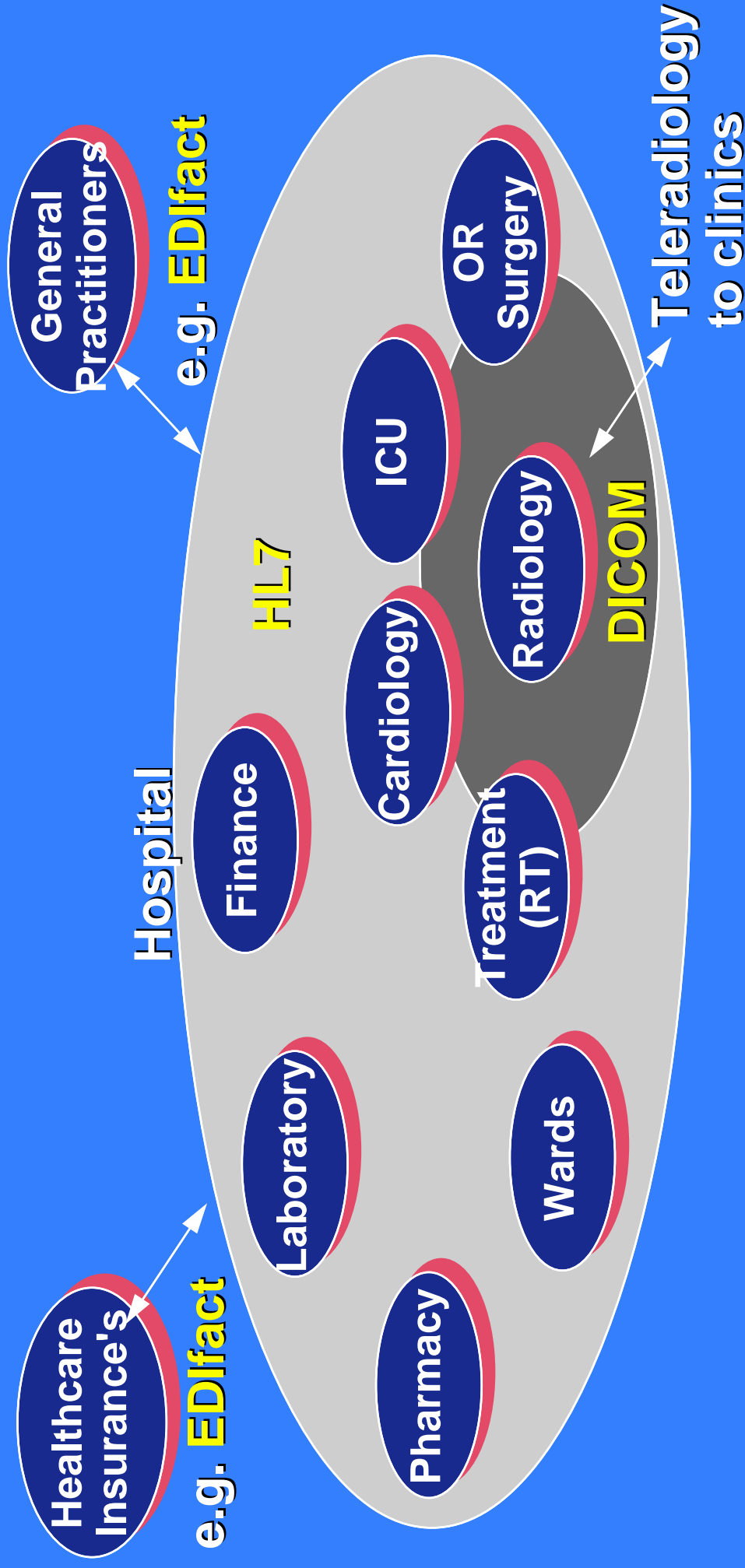
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Presentation Overview

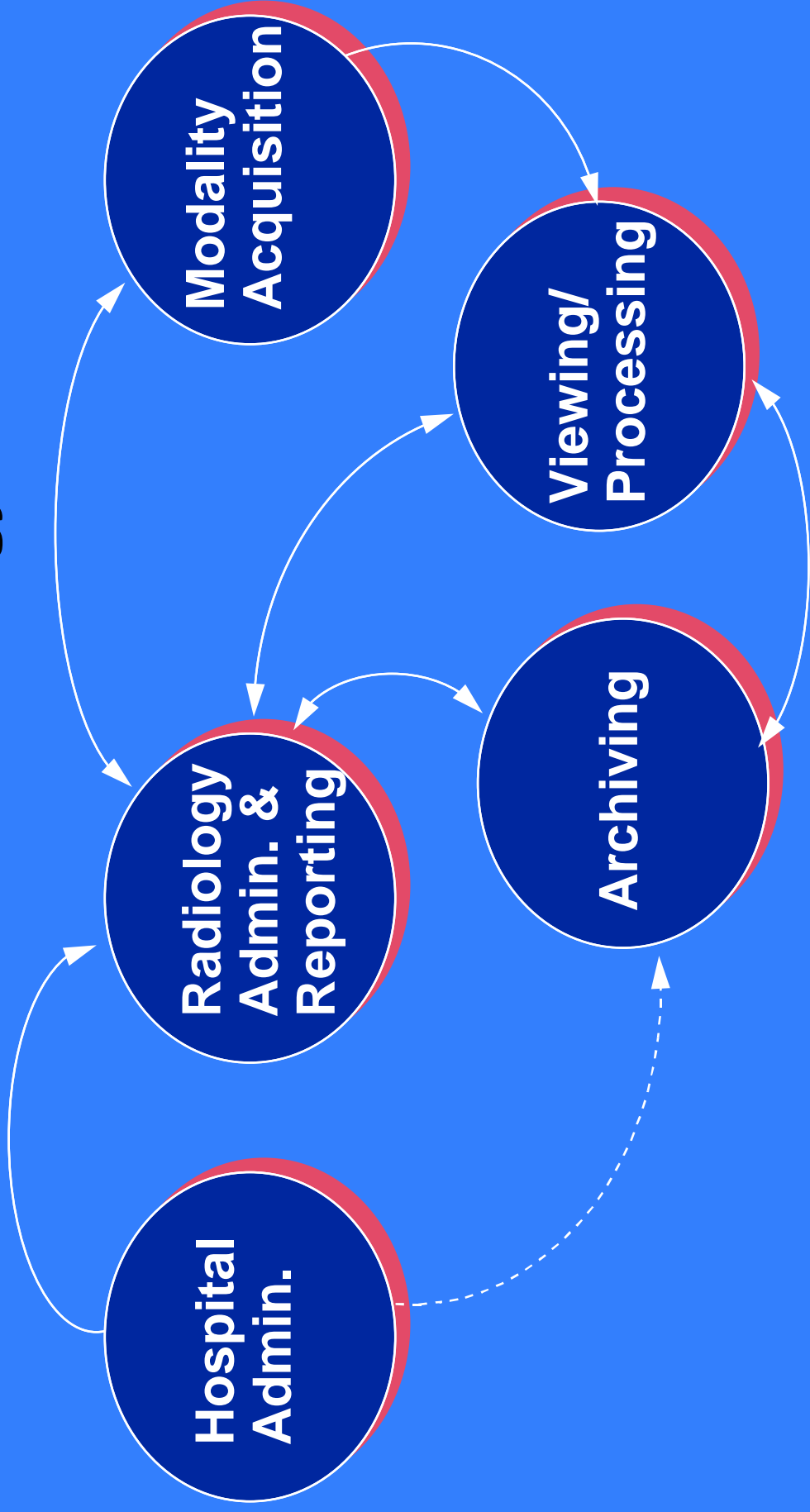
- **Scope and Goal of DICOM**
- **Functionality (Services)**
- **Information Model and Objects**
- **Protocol, Client/Server and Negotiation Aspects**
- **Conformance Statements**
- **RIS Example**
- **Connectivity Versus Interoperability**
- **References**



Healthcare Communication Standards



Different Domains in Radiology



Why DICOM?

- Need for Digital Image Generation
- More need for Digital Transfer/Archiving (PACS)
- More need for Post-Processing
- More need for Cross-Vendor Compatibility
- Need for Communication via Networks/Media



DICOM Goals

By:

- Definition of Semantics & Syntax of Digital Images and Messages
- Definition of Conformance Requirements for DICOM Implementations

Arrange:

- Interchange of Medical Images and Related Data
- Create an Open Environment among Vendors
- Enable/Facilitate Interoperability



DICOM - ACR-NEMA

History:

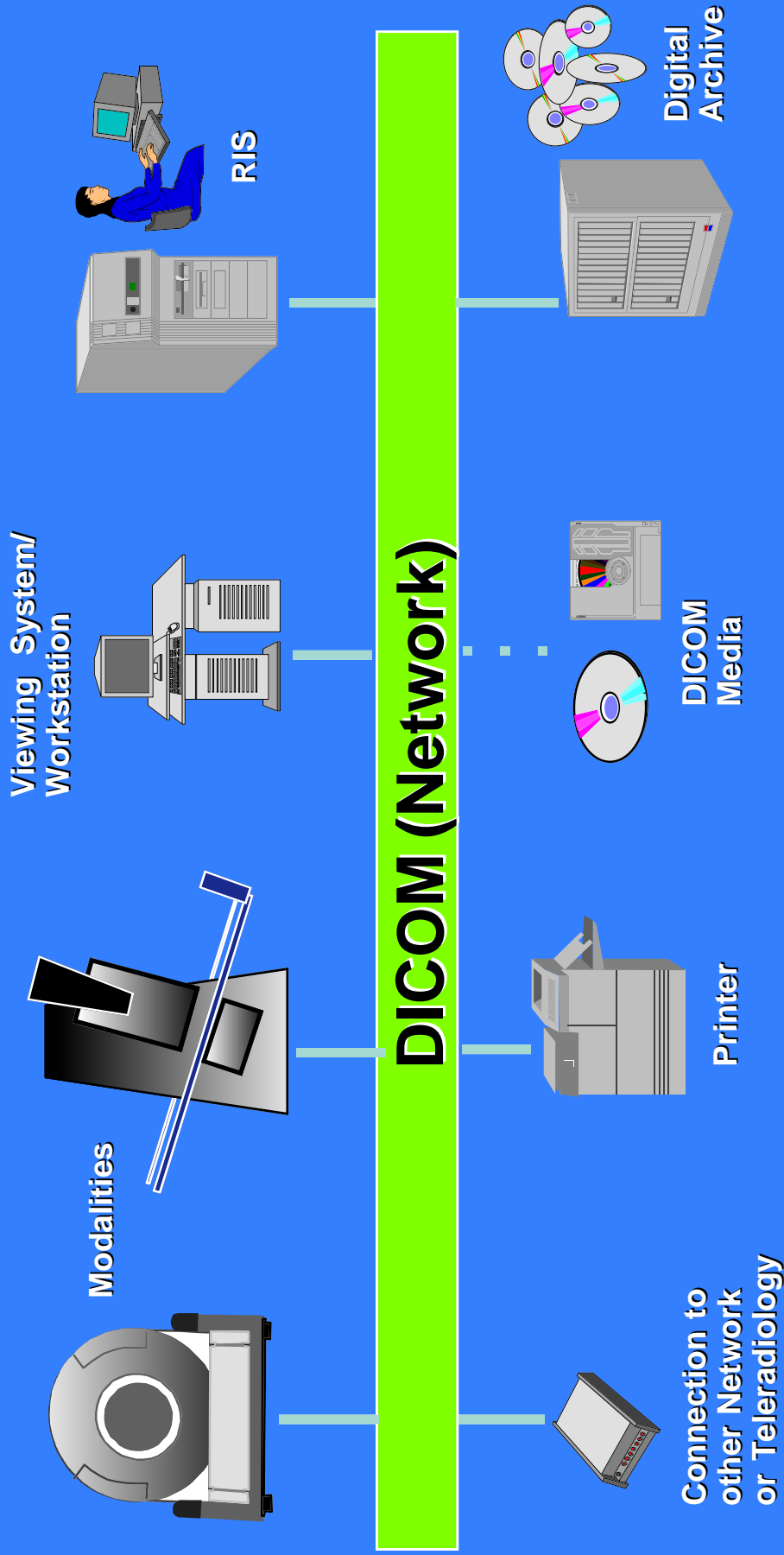
- ACR-NEMA 1.0 and 2.0 in 1985 - 1988
- DICOM (3.0) first parts in 1993
- Continuous Development on DICOM (also with HL7)

DICOM (3.0) improvements w.r.t. ACR-NEMA 2.0:

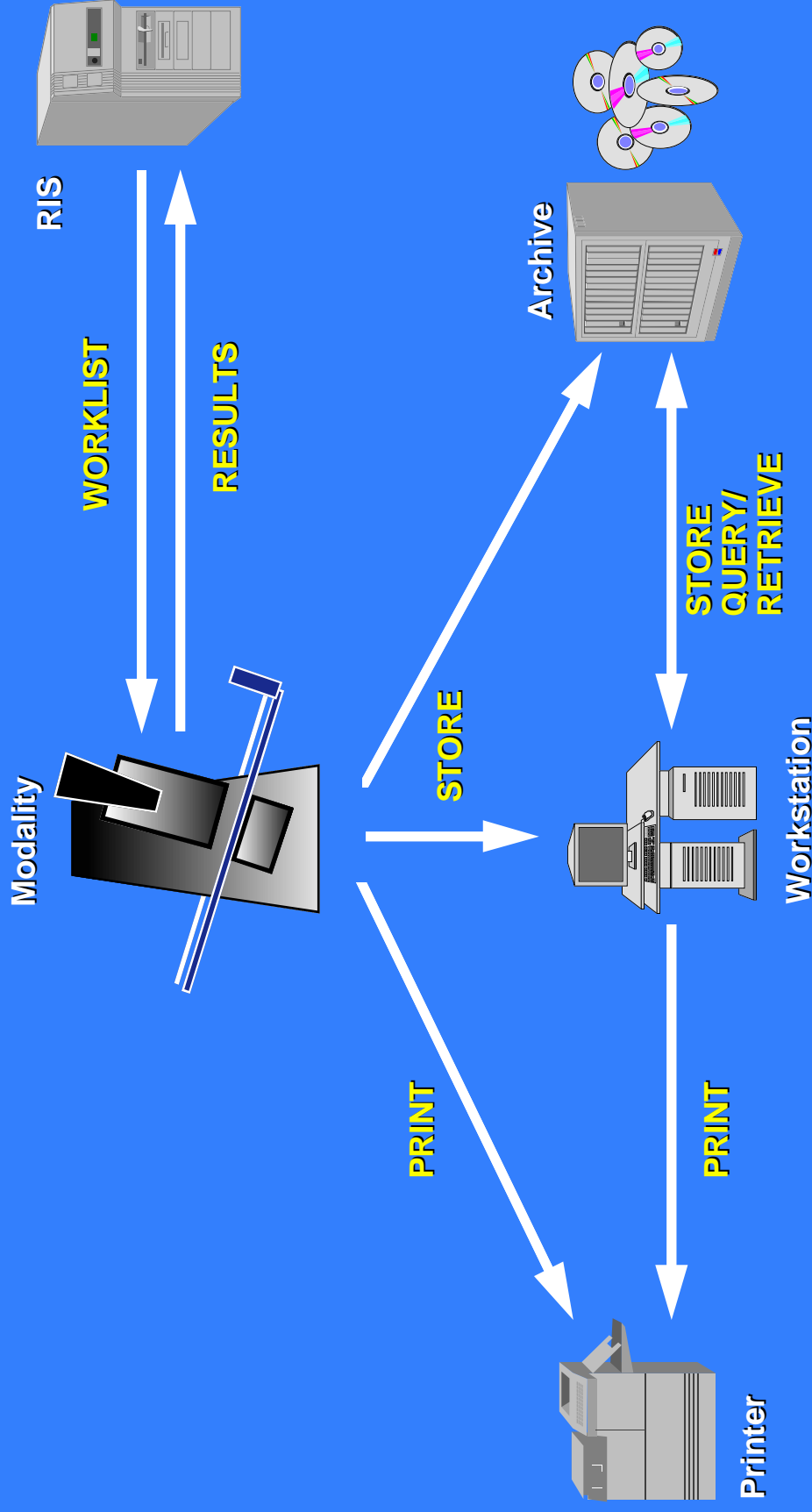
- Networking and Connection Negotiation
- More than only Image Transfer
- Formal Conformance Statements
- More Complete/More Acceptance



Example of Equipment with DICOM Connection



Simple Services Example

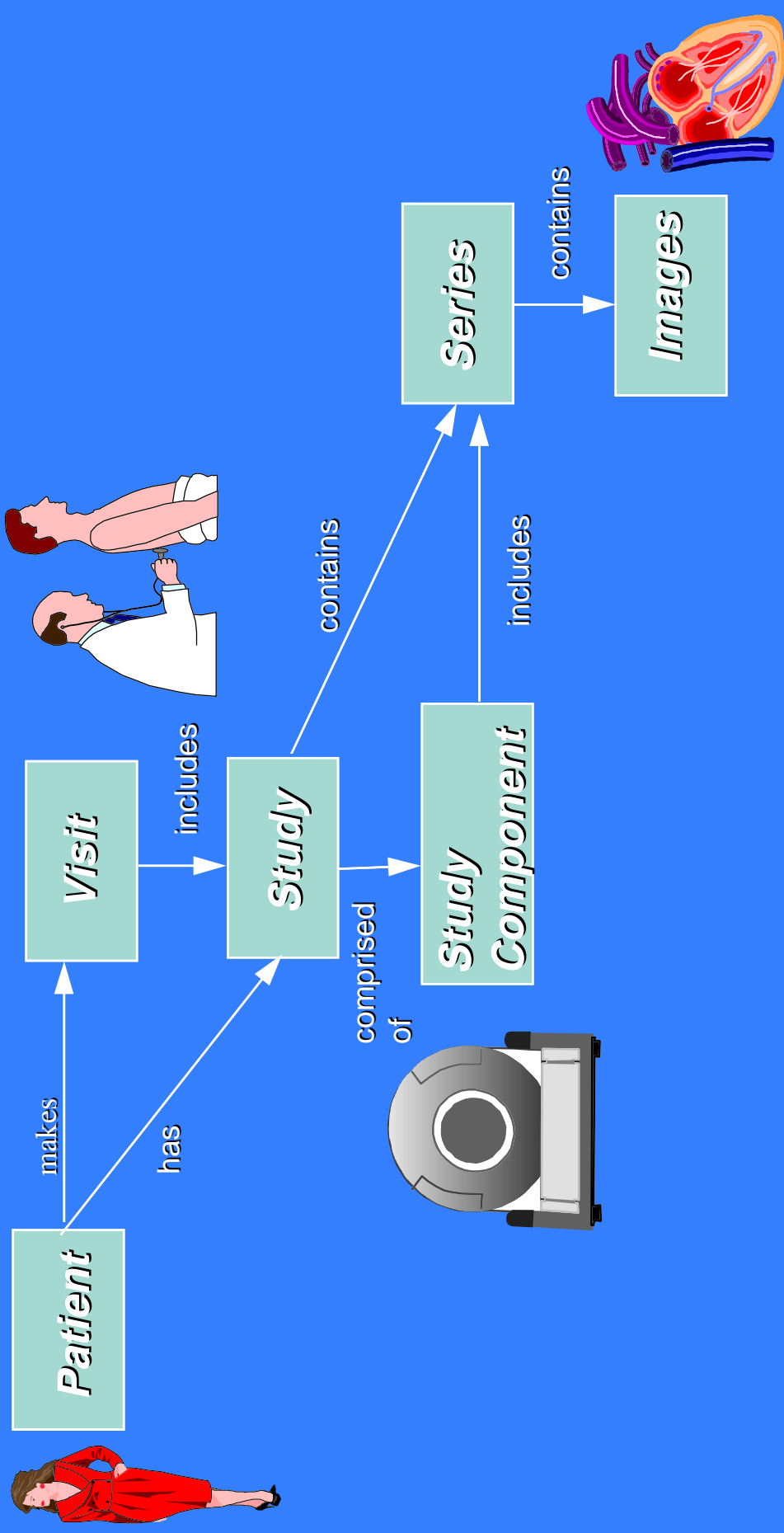


DICOM Functionality: Service Classes

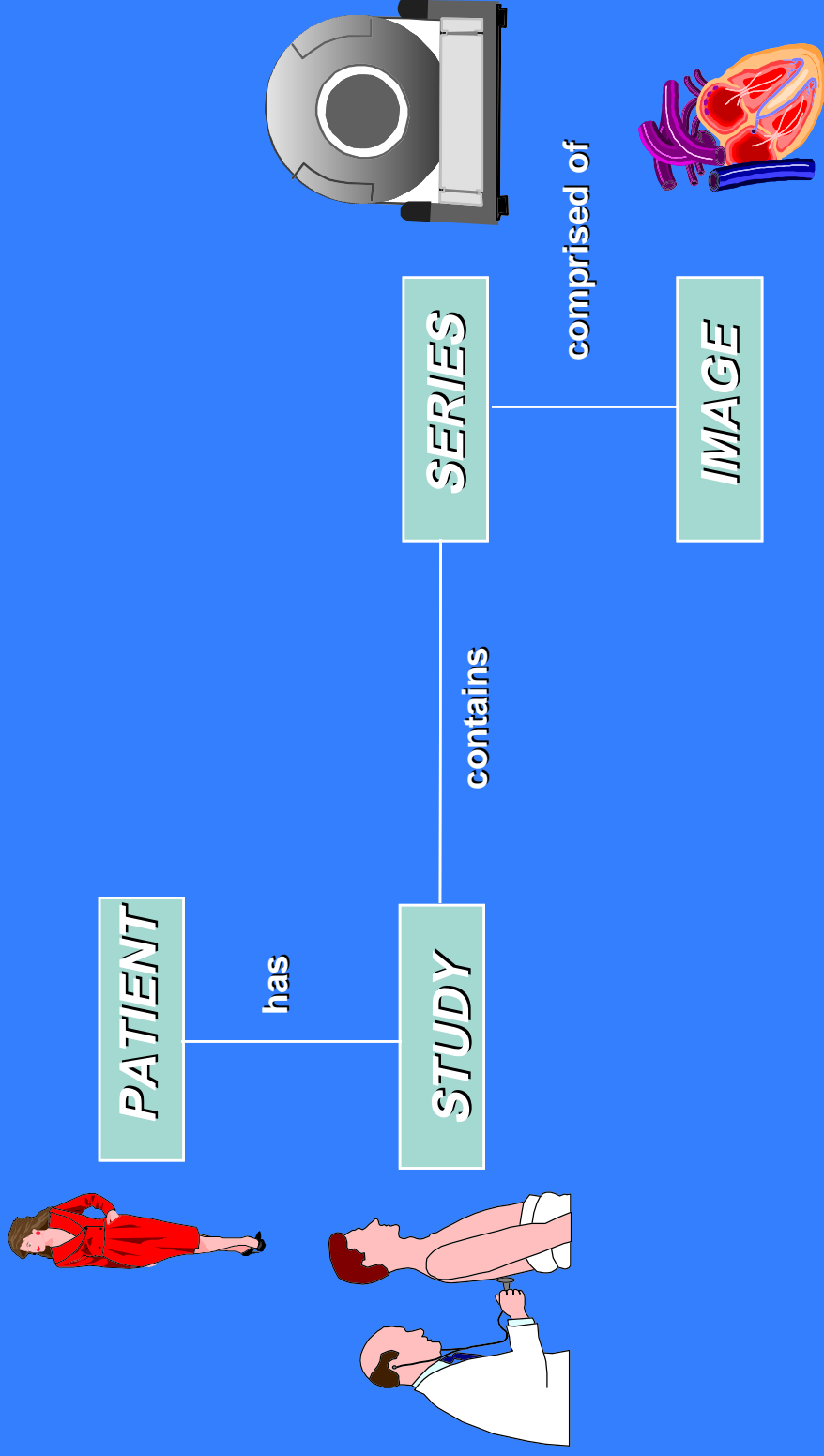
- **Archive/Transfer Images: Store (across network)**
- **Archive/Interchange Images: Media Storage**
- **Query for Information & Retrieve Images**
- **Make Image Hardcopies: Print Management**
- **Patient, Study & Results Management**
- **RIS-Modality: Worklist Management**
- **Test Connectivity: Verification**



DICOM Application Model (Real World) - Simplified



DICOM Information Model (simplified)



Query/Retrieve Models (Image Information)

- **Patient Root** (all levels from Patient downwards)
- **Study Root** (all levels from Study downwards)
- **Patient/Study Only** (all images dealt with implicitly)

Note, for naming in actual service requests:

- **FIND** is used often for Querying Information
- **GET/MOVE** is used often for Retrieving Images



Attributes

- Patient Name
- Patient ID

.....

- Accession Number
- Study Date

.....

- Modality Type
- Series Date

.....

- Image Type
- Rows and Columns
- Pixel Data

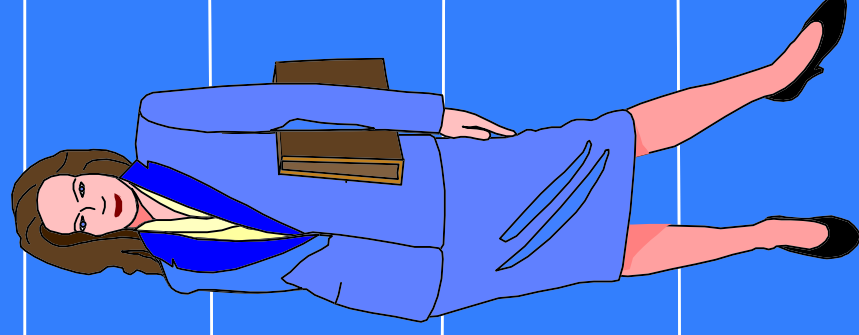
.....

Patient

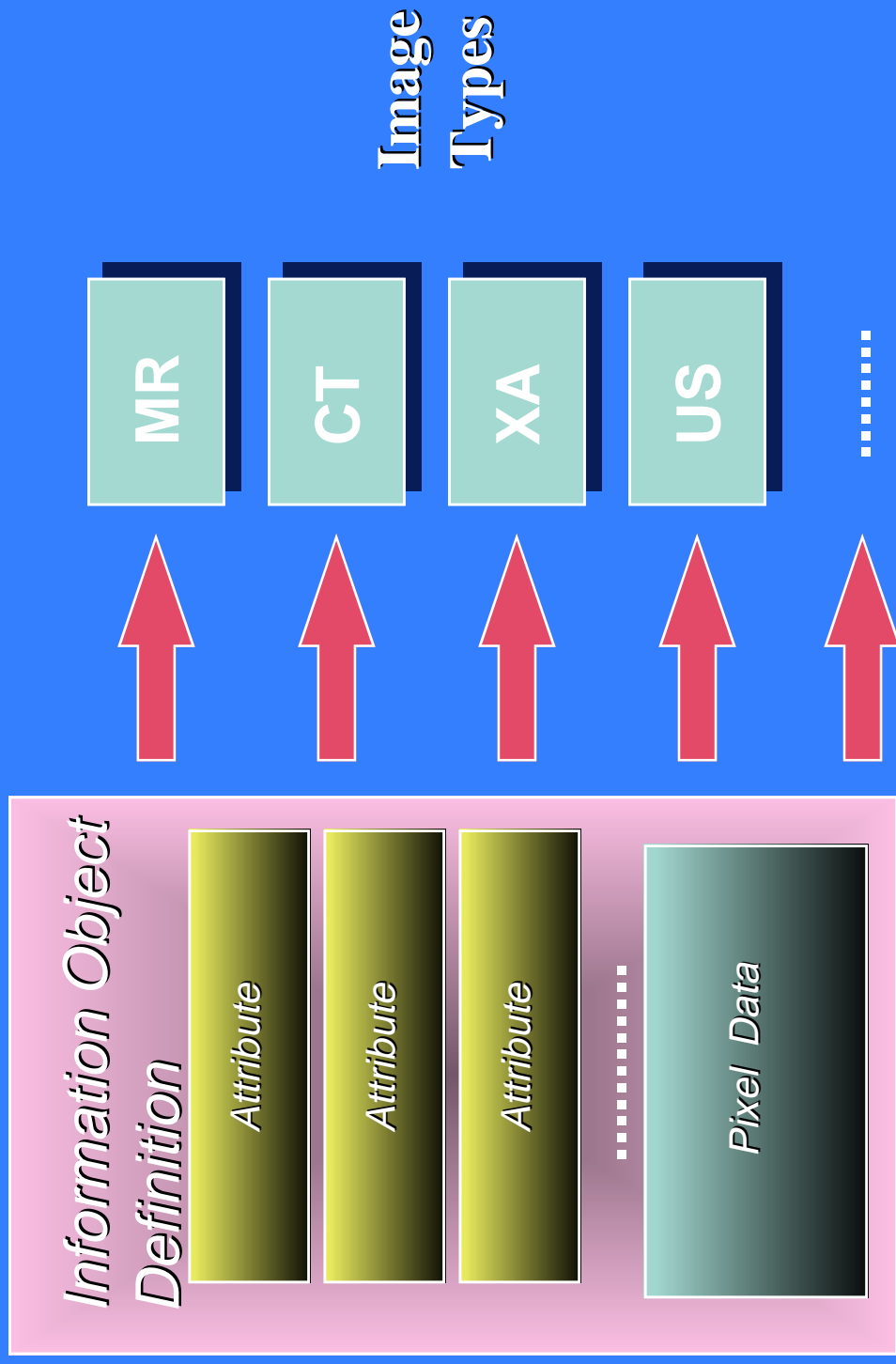
Study

Serie

Image



Objects Definitions - (e.g. Images)



Attribute Types

- (1) **Mandatory - Always Present with a Value**
- (2) **Mandatory - But allowed to be Empty**
- (1C), (2C) **Conditional - Type 1 and 2**
- (3) **Optional - also allowed to be Empty**

Objects (e.g. Different Image Types) can have different Type specifications for the same Attribute. For example:

- **X,Y,Z Image Orientation for CT type 1, not in plain X-ray**
- **Image Type Generic type 3, for XA and CT type 1**



Attribute Definitions (Data Dictionary)

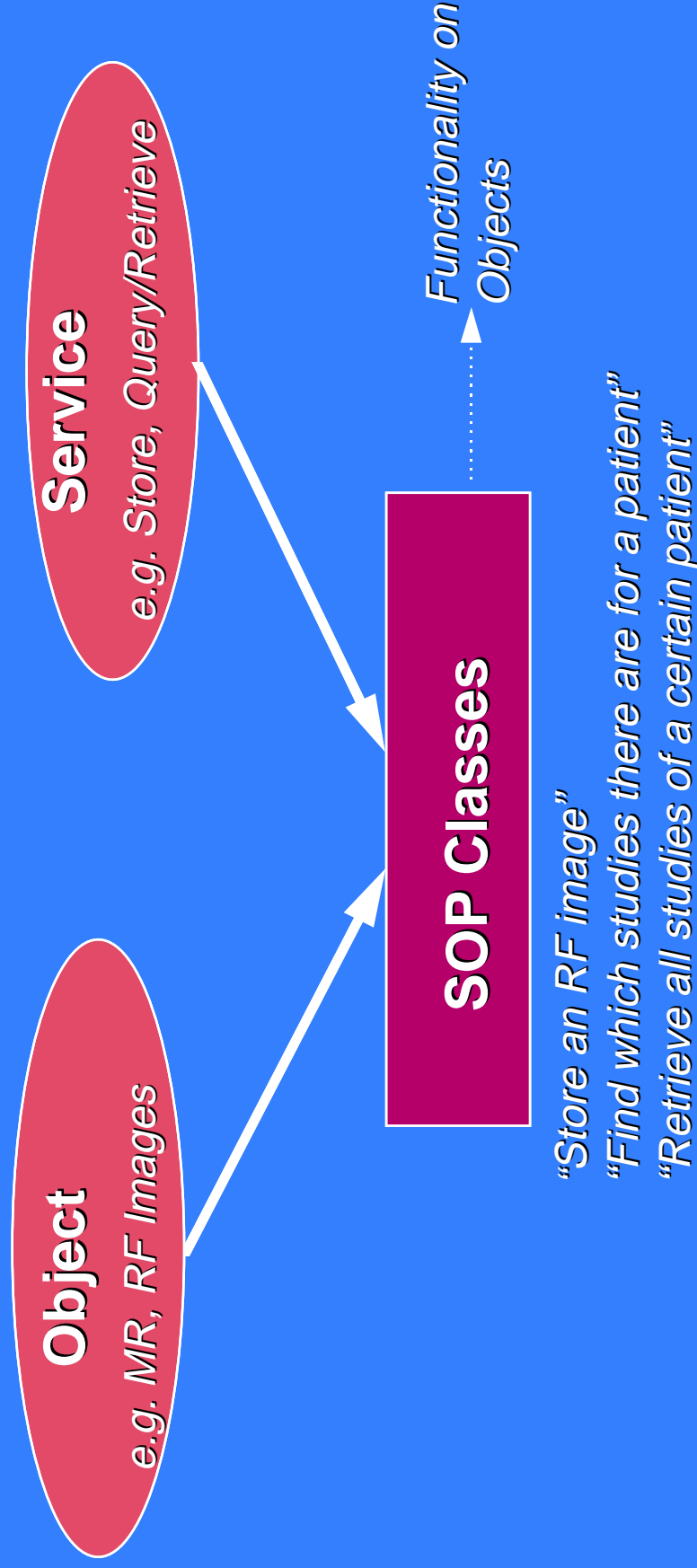
- **Attribute Name**
- **Tag (e.g. 0008,0102) - Hexadecimal**
- **Value Representation (VR): date, integer, patient name, ...**
- **Value Multiplicity: number of values must/may be present**
- **Description: semantics**

Private Attributes may be defined by vendors, and are always Optional. Conflicts in Tags prevented by DICOM.



Services on Objects

SOP Class: a Method to Operate on an Information Object



Unique Identifiers (UIDs)

- Identification Method which is **World-Wide Unique**.
 - Unique Identifiers are defined for all **SOP Classes**.
- Important for the Conformance Statement.

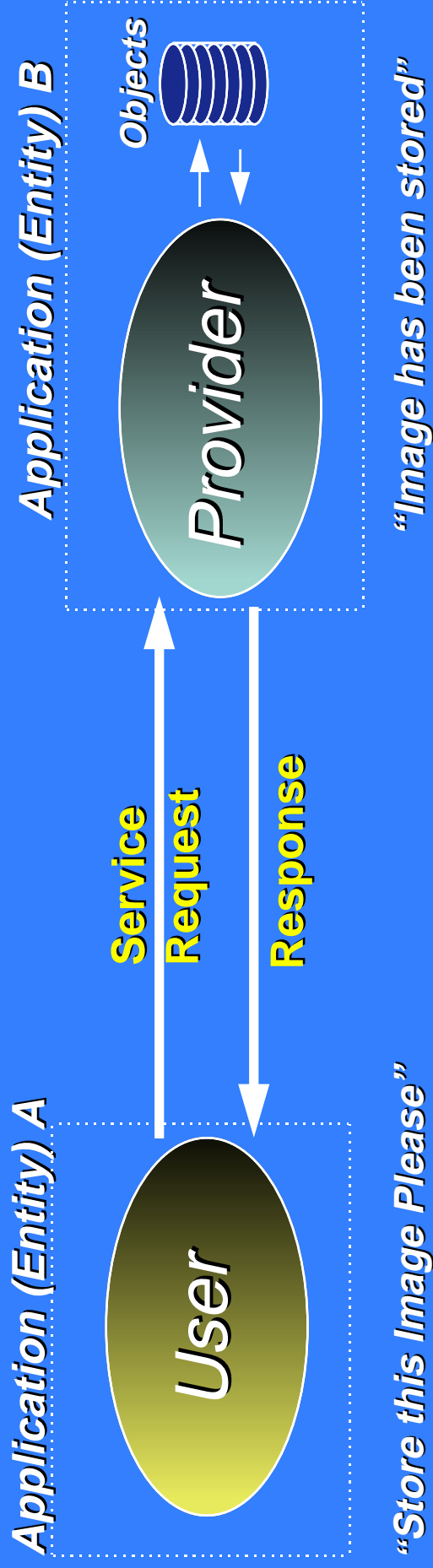
Also, a Unique Identifier is given to all:

- Studies (Study Instance UID)
- Series (Serie Instance UID)
- Images (SOP Instance UID)

These UIDs are for instance used for Retrieval.

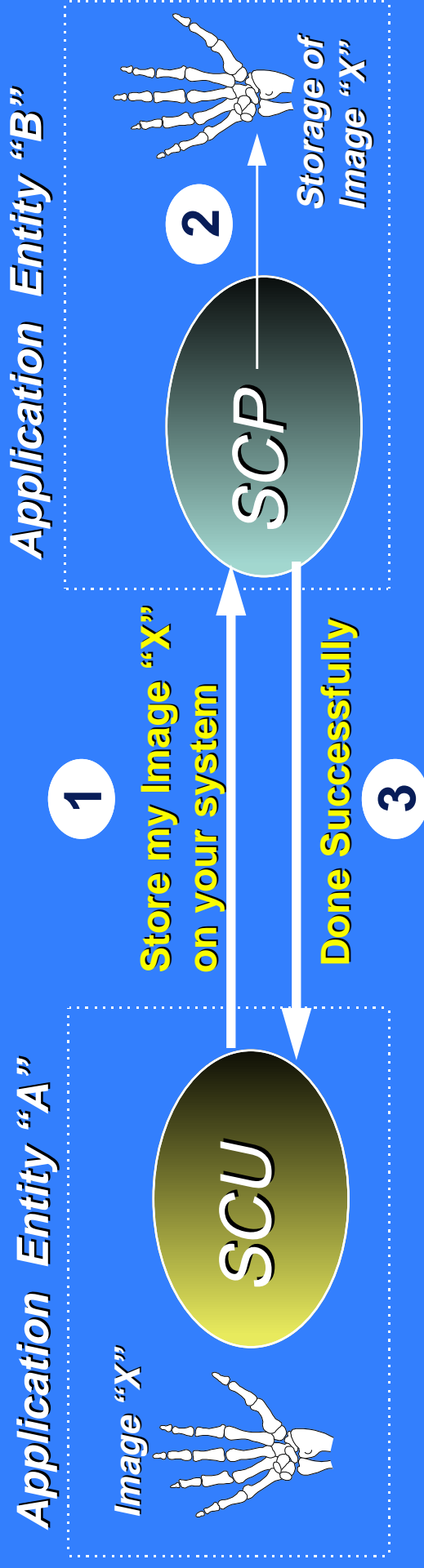


Client/Server Concept



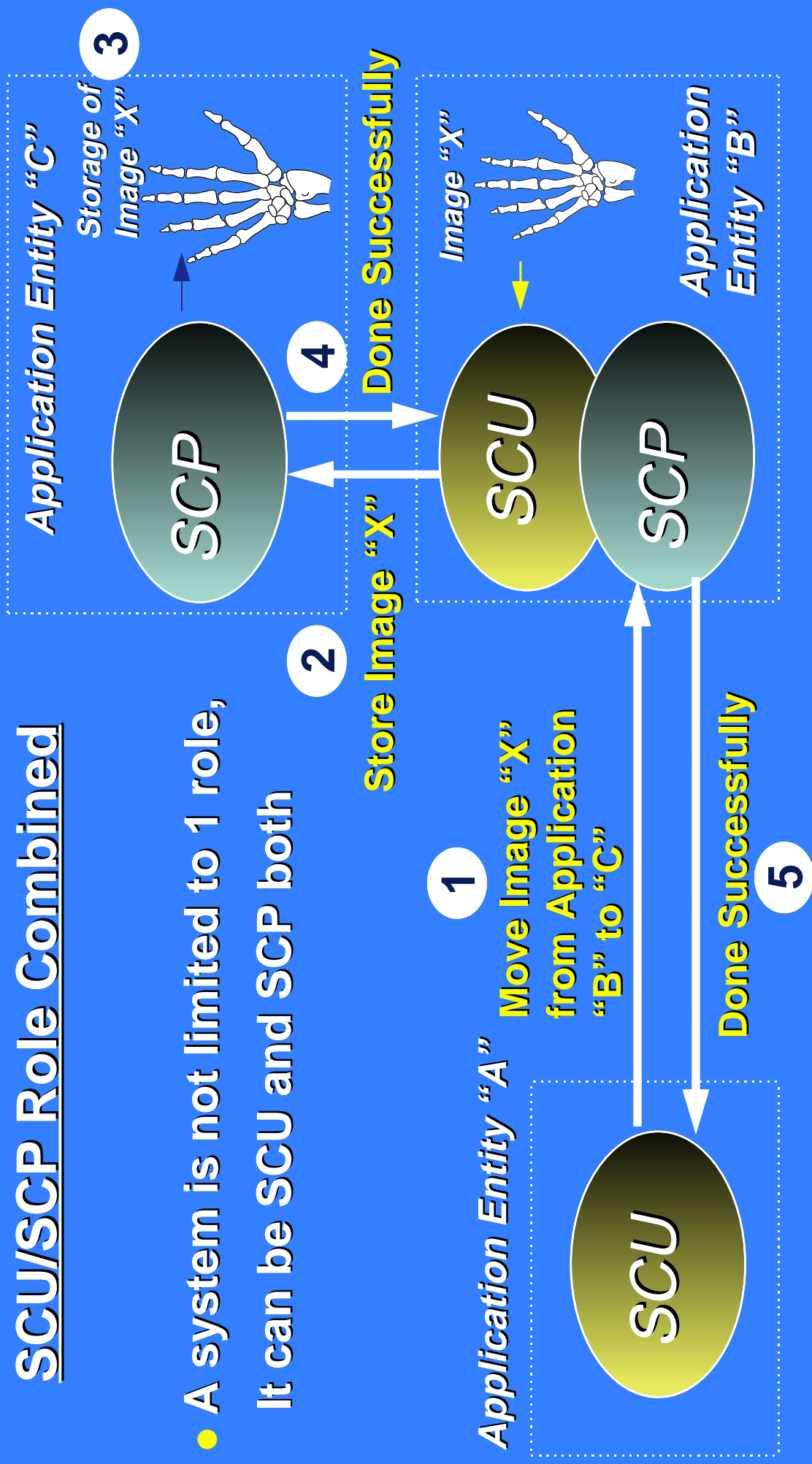
SCU/SCP Roles

- Client is called “SCU” (Service Class User)
- Server is called “SCP” (Service Class Provider)

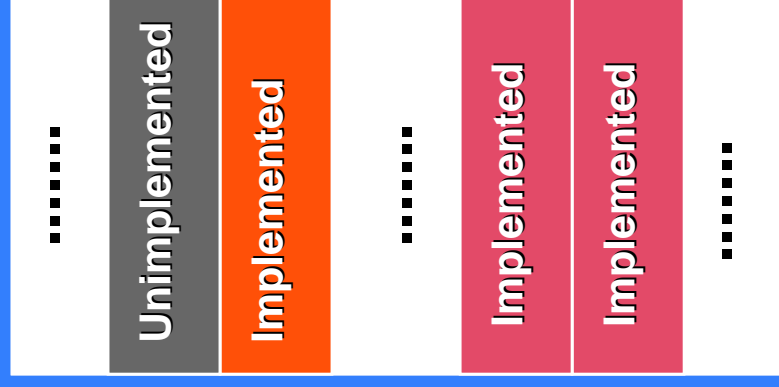
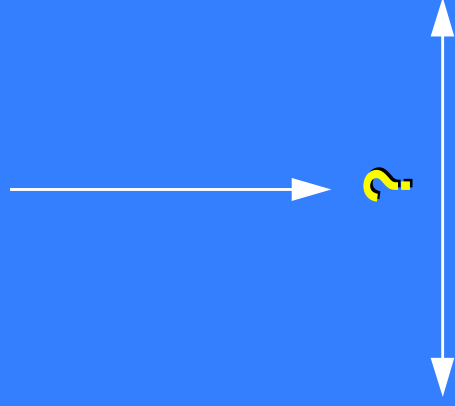
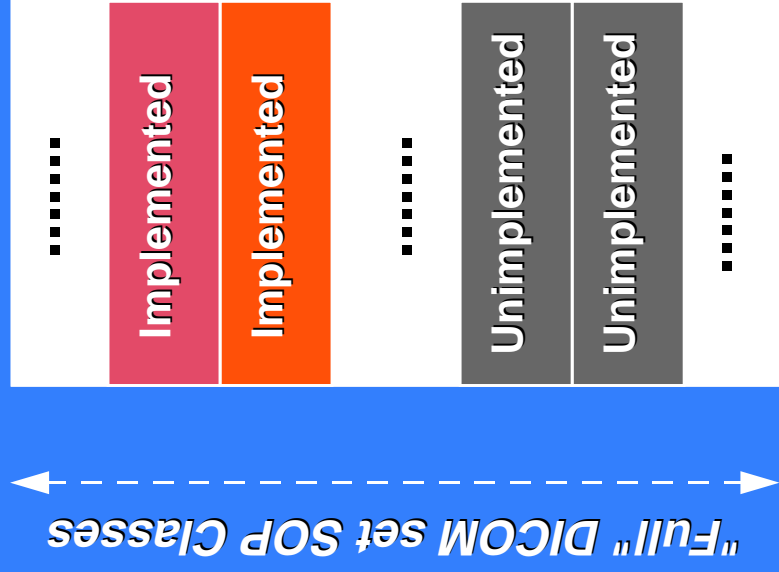


SCU/SCP Role Combined

- A system is not limited to 1 role, It can be SCU and SCP both



DICOM - Can we Communicate?



System A

System B



Association Handling

First:

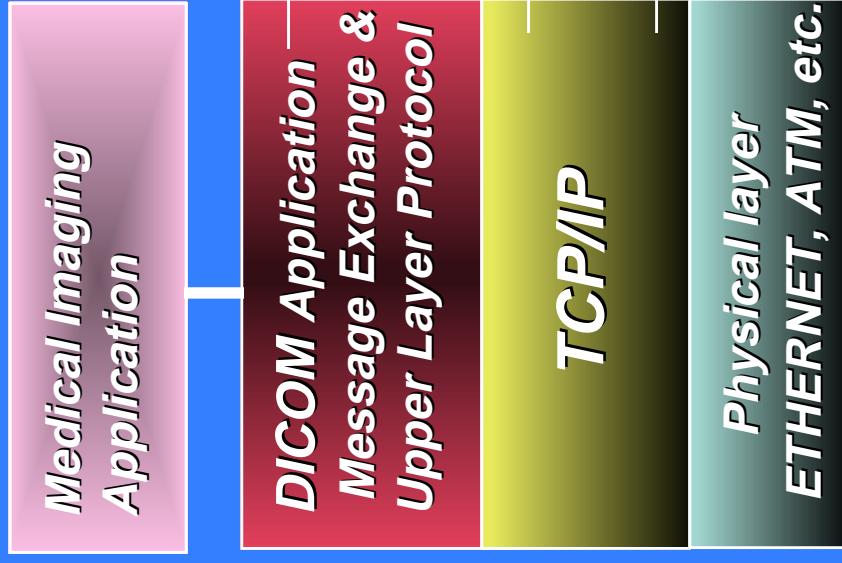
- Initiate a Connection



Then Agree on:

- Which SOP Classes are to be used
- Client and Server Roles (SCU/SCP)
- Encoding (Transfer Syntax)
- Other Communication Parameters

Connection Identification required per Layer



Networked environment

Unique for each Application in the Network

Application Entity Title

Only relevant for SCPs SCU must configure this to send to

Listen Port

Unique for each System in the Network

IP Address

Note: the host name is only for local reference on a system



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Association Handling

- Which SOP Classes are supported by each system
- Client and Server Roles (SCU/SCP)
- Encoding (Transfer Syntax's)
 - Implicit Little Endian (DICOM default)
 - Explicit Little Endian (attribute type added)
 - Explicit Big Endian (byte swapped if necessary)
 - JPEG Lossless
 - JPEG Lossy (information loss)
- Maximum Package Size to be used
- Number of Associations Supported (by SCU and SCP)



Conformance Statement

- **Mandatory Document for all DICOM compliant systems**
Request the document for all systems to connect with
- **Used to Check if/what level of Connectivity is possible**
Compare list of Supported SOP Classes
Compare list of Supported Transfer Syntax's
BEFORE actual installation
- **Retrieve Connection and Configuration Information**
of the systems to connect to
- **Check for Extensions and Limitations**



Conformance Statement - Example

SOP Classes supported as SCU

MR Image Storage	1.2.840.10008.5.1.4.1.1.4
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
Patient Root Model Query	1.2.840.10008.5.1.4.1.2.1.1
.....

Proposed Presentation Contexts

MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Implicit Little Endian	1.2.840.10008.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Explicit Little Endian	1.2.840.10008.1.2.1
.....

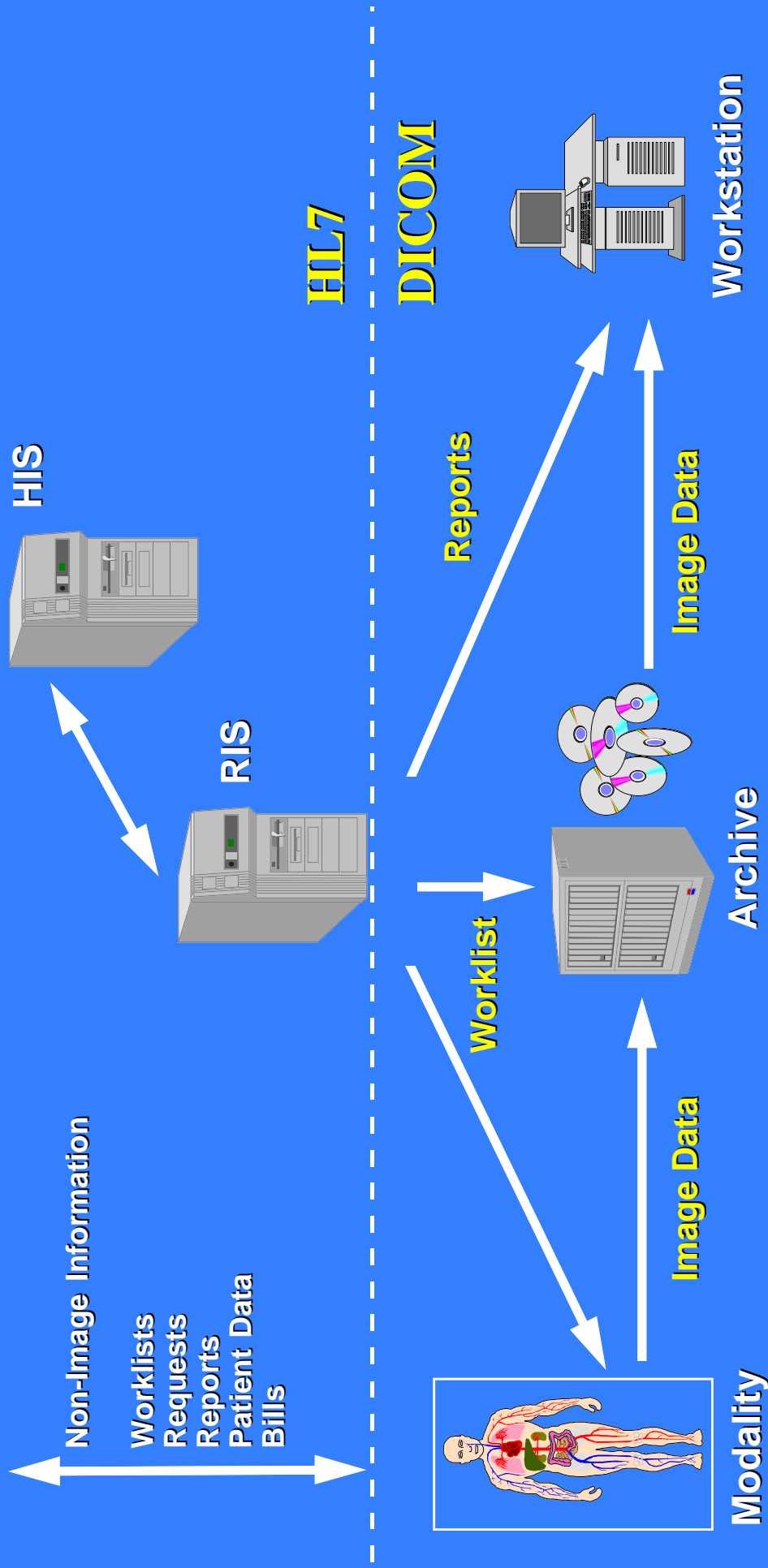


DICOM Developments

- Security
- Reporting
- Storage Commit
- Print Storage
- New Image SOP Classes (e.g. RT and endoscopy)
- Extension of Standardization of Data Elements
- Display Standards (Image Quality)
- More focus on Interoperability
- Coupling with HIS/RIS World (e.g. HL7)

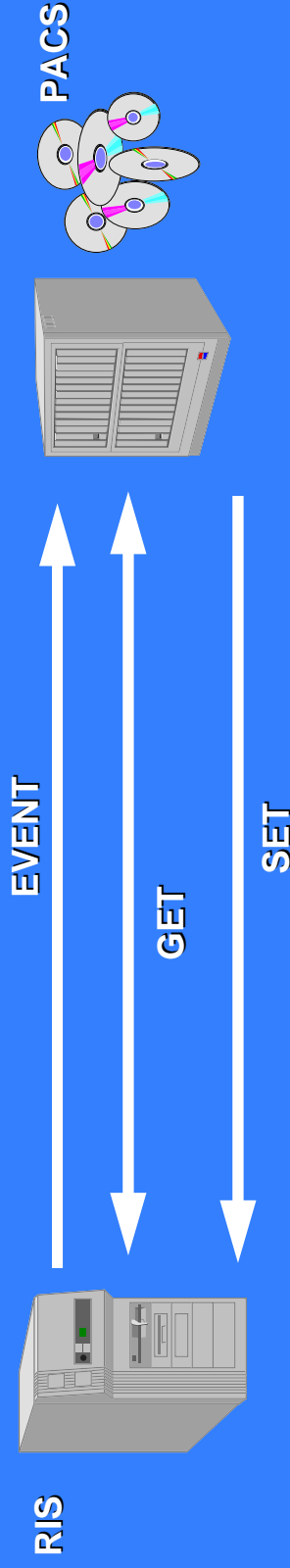


An Example - RIS Connection



RIS Connection Models - 1

- **RIS Controlled** Connection (e.g. RIS-PACS)
 - Events by RIS (e.g. with UID values)
 - GET by e.g. PACS detailed information from RIS



- **Detached Patient/Study/Results Management SOP Classes**

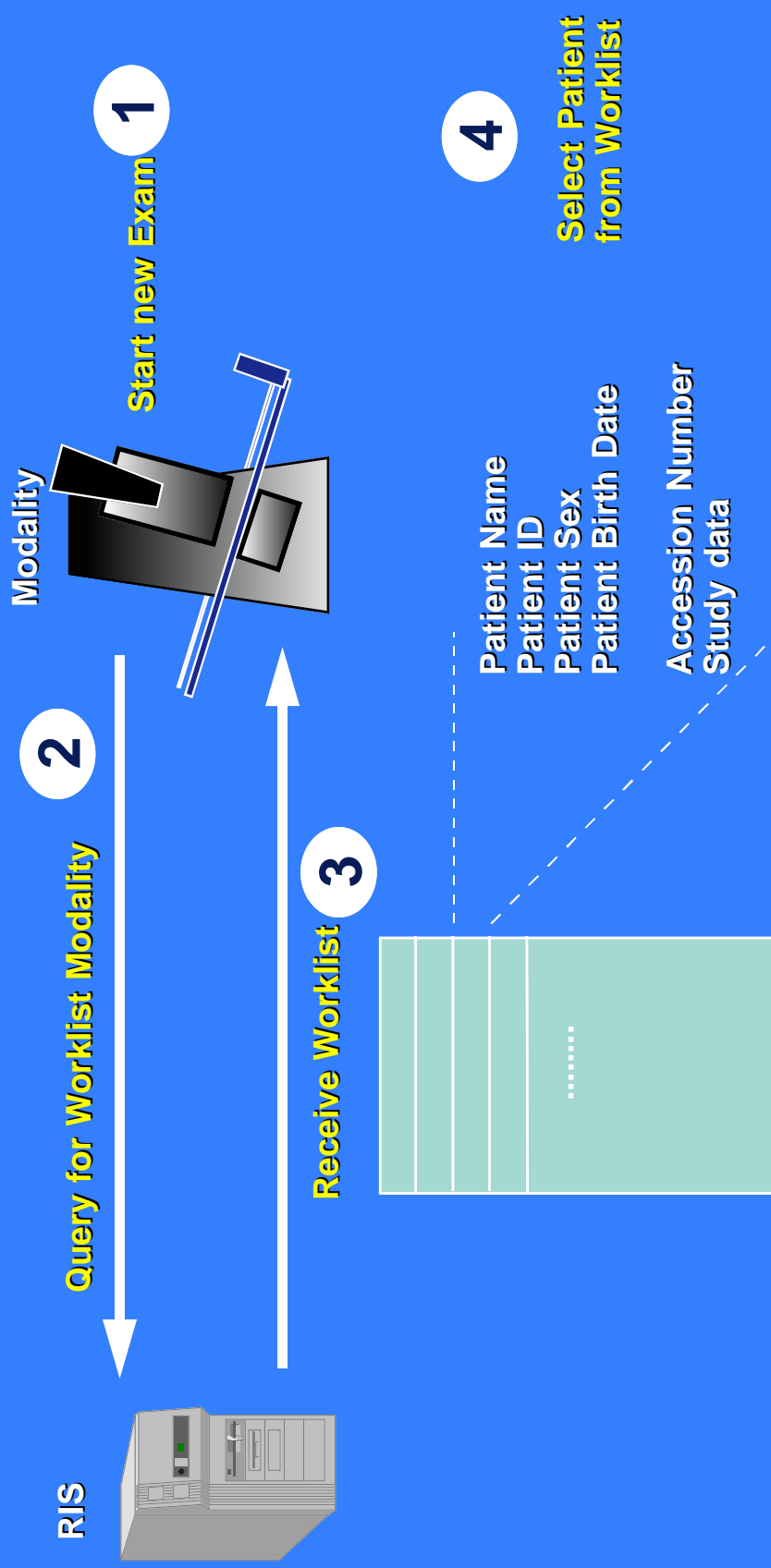
RIS Connection Models - 2

- **Modality Initiated** Information Retrieval
 - Query by Modality
 - RIS provides information in Query Response



- **Worklist Management SOP Class**

Worklist Management - Query



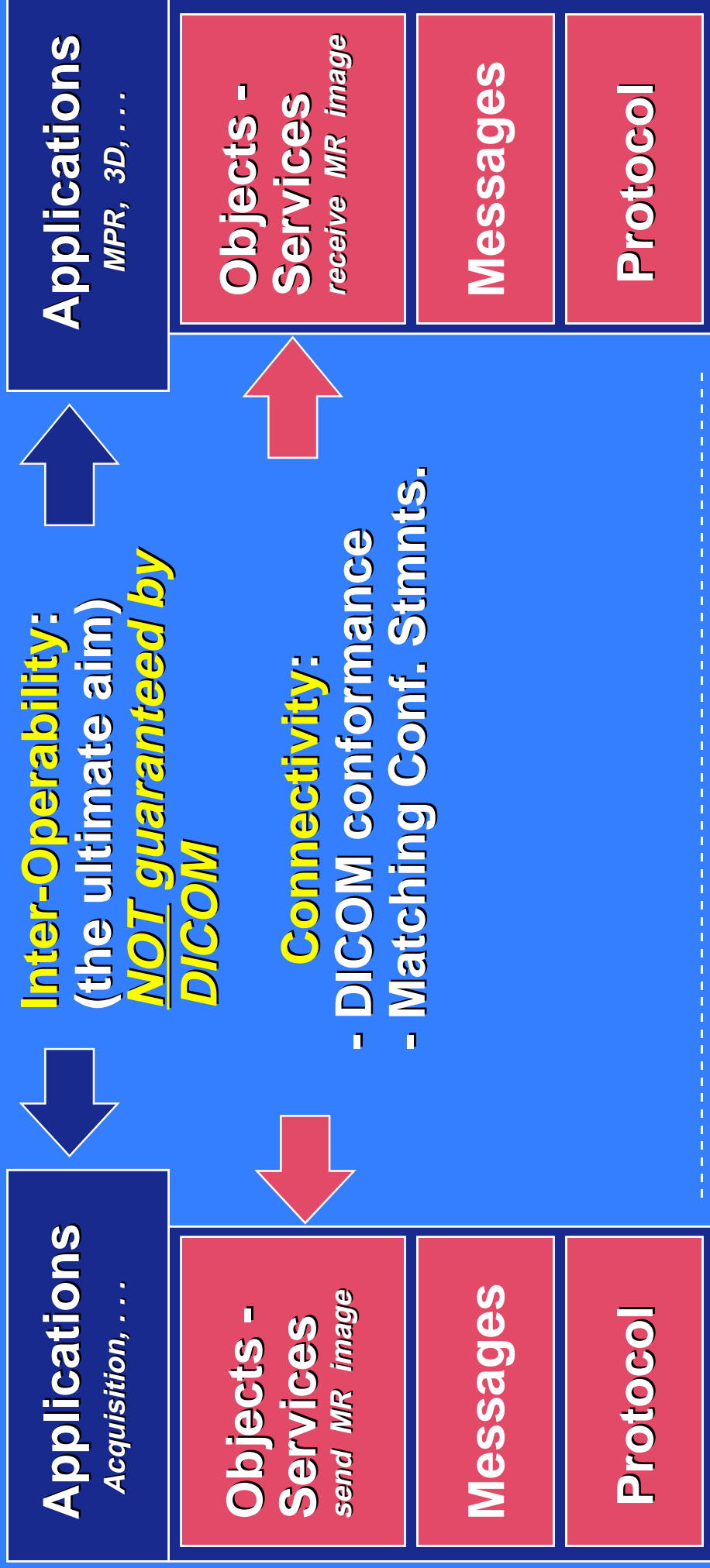
Results Management



**Study Component: contains produced image as reference
(no image data)**

**New “Performed Procedure Step” (extension Study Comp.)
also includes X-ray dose, material used, contrast used, etc.**

Connectivity Vs. Interoperability



Application Interoperability Check

Applications can **Require (!)**:

- Optional Attributes
- Private Attributes (not in DICOM Standard)
- Private SOP Classes (not in DICOM Standard)
- Special Semantics of Attributes/Special Rules for Usage

Thus, we need a **Detailed Description** of:

- Required Application Functionality
 - Required Attributes for this
- to **Verify Interoperability** on before-hand

DICOM Standard about Interoperability

DICOM Part P.S. 3.1 - “Goals of the DICOM Standard”:

“Even though the DICOM Standard has the potential to facilitate implementations of PACS solutions, use of the standard alone does not guarantee that all the goals of a PACS will be met.

This standard facilitates Interoperability of systems claiming conformance in a Multi-Vendor environment, but does not, by itself, guarantee Interoperability”



Further Information

Internet Sites for more General DICOM Information:

- <http://www.nema.org/nema/medical/dicom>
- <news://comp.protocols.dicom>
- ftp://ftp.philips.com/pub/ms/dicom/DICOM_Information

Philips Medical Systems specific Information:

- <http://www.philips.com/ms/solution/connect>
- ftp://ftp.philips.com/pub/ms/dicom/Medical_Images
- ftp://ftp.philips.com/pub/ms/dicom/Conformance_Stmnts

