

DICOM

Exchanging Imaging Data

**Modality Images (and other types of objects)
Finding and Retrieving Objects**

Charles Parisot – Harry Solomon

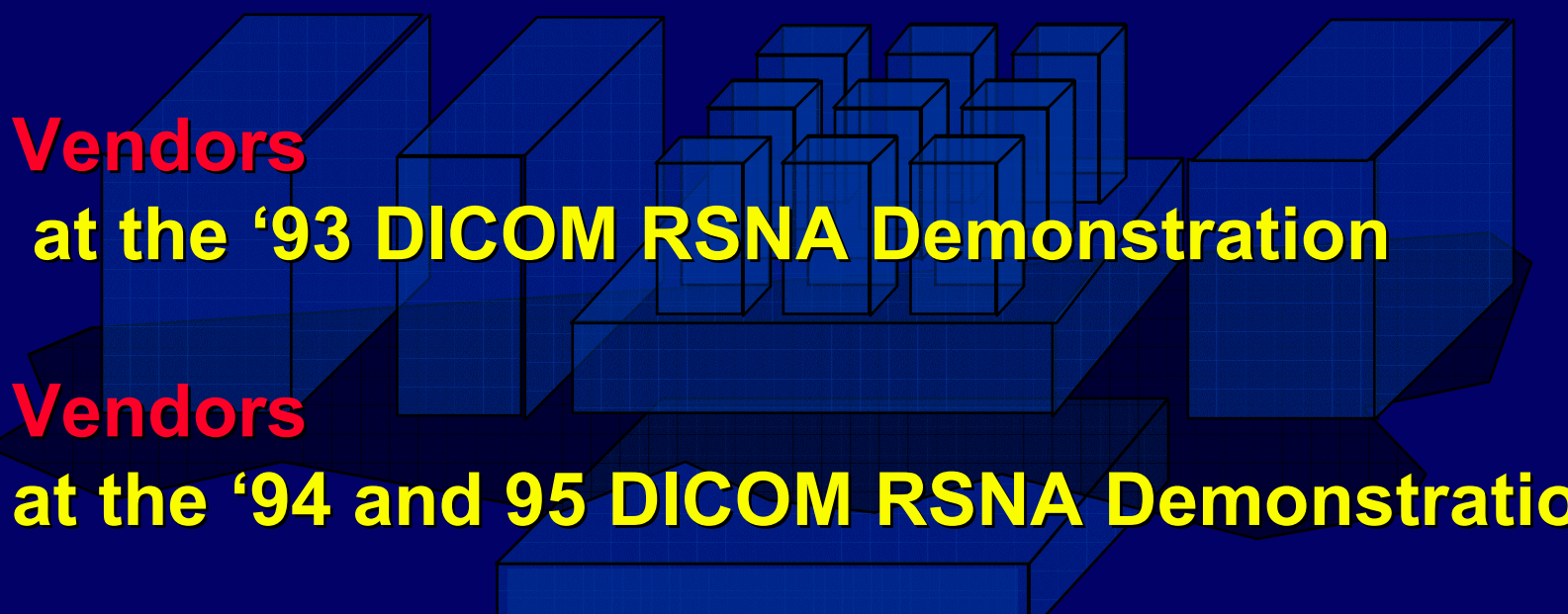
DICOM Conference 2005 - Budapest

DICOM...



Is a **GLOBAL STANDARD** of Communication,
developed under joint efforts of
ACR (American College of Radiology)
NEMA (National Electrical Manufacturers Assoc.)
ESC (European Society of Cardiology)
ACC (American College of Cardiology)
SFR (Société Française de Radiology)
DRG (Deutsche Röntgengesellschaft)
AAO (American Academy of Ophthalmology)
AAD (American Academy of Dermatology)
CAP (College of American Pathology)
JIRA (Japanese Radiology Vendors Association)
COCIR (European Radiology Vendors Association)
And 25 plus vendors.....

DICOM first release approved October '93

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- **20 Vendors** at the '93 DICOM RSNA Demonstration
 - **40 Vendors** at the '94 and 95 DICOM RSNA Demonstrations
 - **More than 100 Vendors** at RSNA 96

**Since 1997 – Too many implementations to count !
Google® over 2,000,000 references**

DICOM documents updated yearly

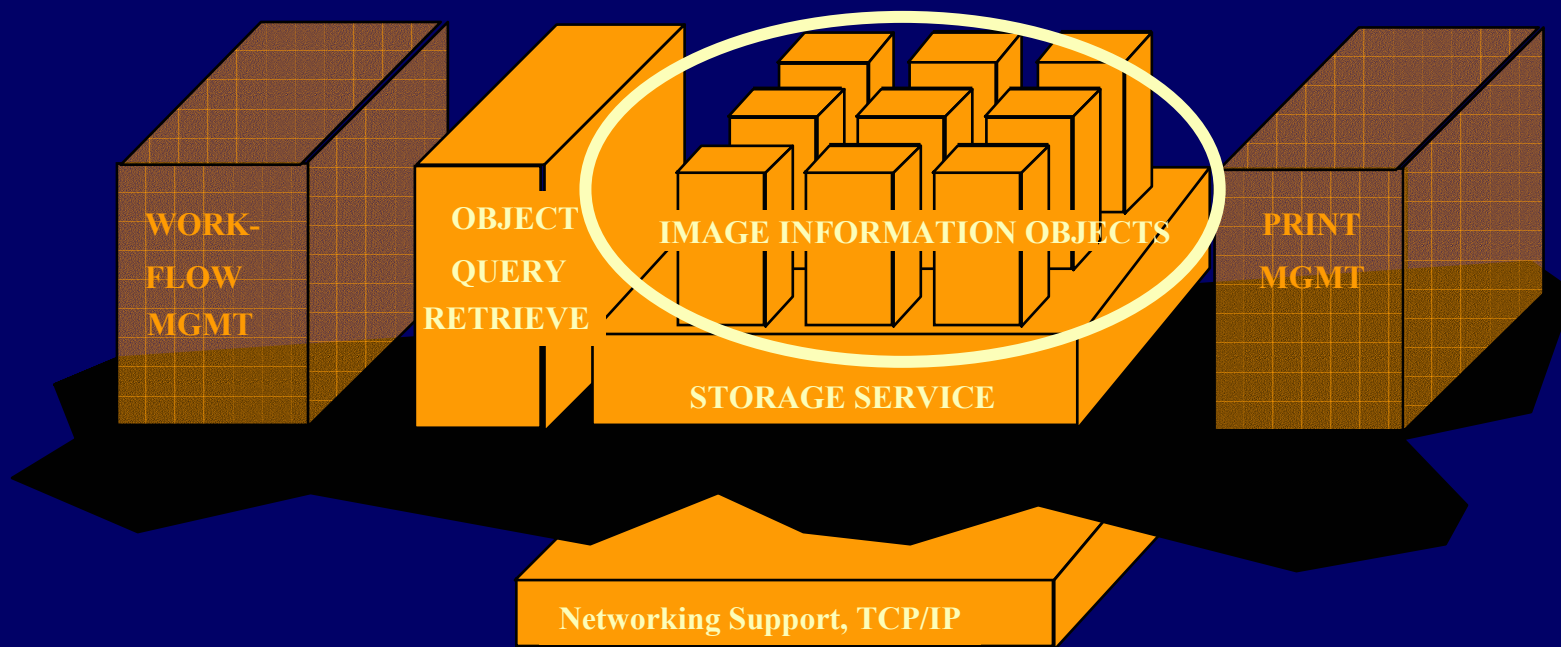
DICOM 2004 is a compatible extension of DICOM 2003
+ 119 Clarifications/Changes + 25 Supplements

Available for free from the DICOM website:
dicom.nema.org

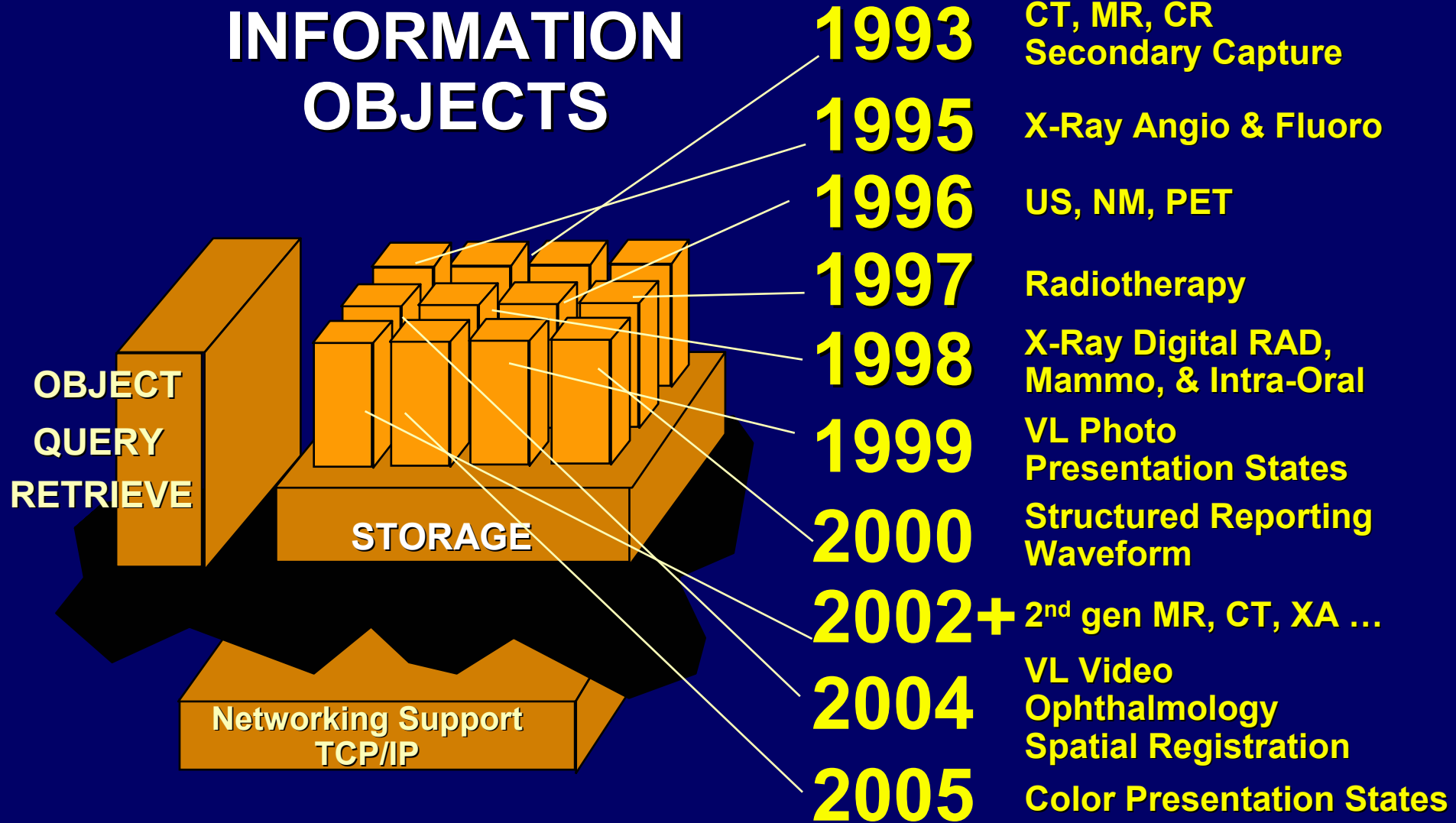
But DICOM 3.0, DICOM 96, DICOM 98, DICOM 99, DICOM 2000
DICOM 2003 are only document publishing names.

**This has no direct impact on existing
Product Conformance !**

DICOM for Image Transfer



DICOM Spans Most of Medical Imaging



DICOM Spans Most of Medical Imaging

DICOM transfers not only Images, but also:

- Therapy Plans, Structures, etc.
- Waveforms
- Structured Documents and Reports
- Image Controls and Relationships

DICOM transfers not only Radiology images, but also:

- Cardiology (X-Ray Angio, US, NM)
- Oncology (RT Portal images, fused CT/PET)
- Dentistry (X-ray Intra-Oral)
- Ophthalmology
- Endoscopy, Pathology, Microscopy, etc.

1993

CT, MR, CR
Secondary Capture

1995

X-Ray Angio & Fluoro

1996

US, NM, PET

1997

RadioTherapy

1998

X-Ray Digital RAD,
Mammo, & Intra-Oral

1999

VL Photo
Presentation States

2000

Structured Reporting
Waveform

2002+

2nd gen MR, CT, XA ...

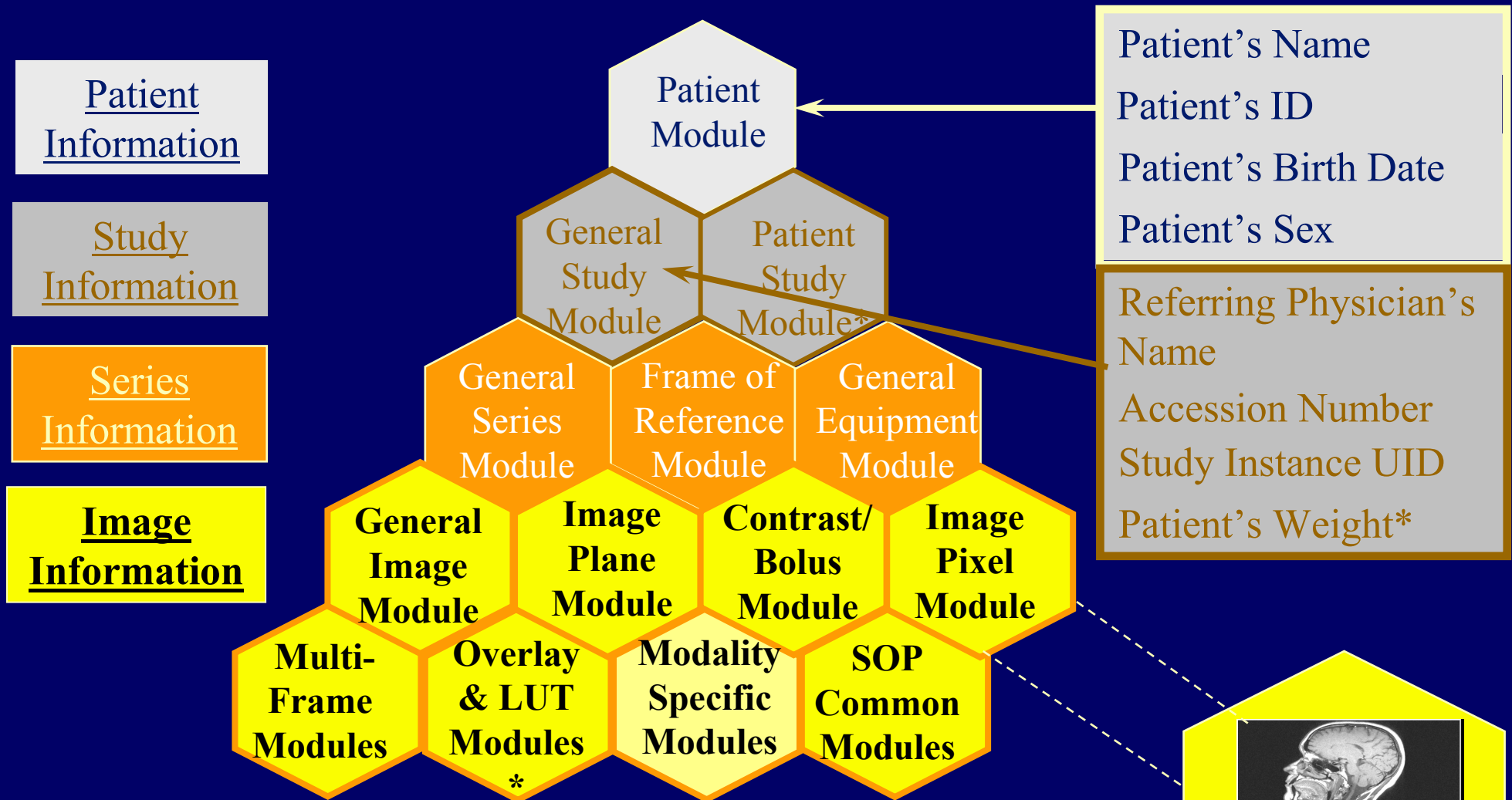
2004

VL Video
Ophthalmology
Spatial Registration

2005

Color Presentation States

Information Object Definitions



Not only contains pixel data but also key information about the image



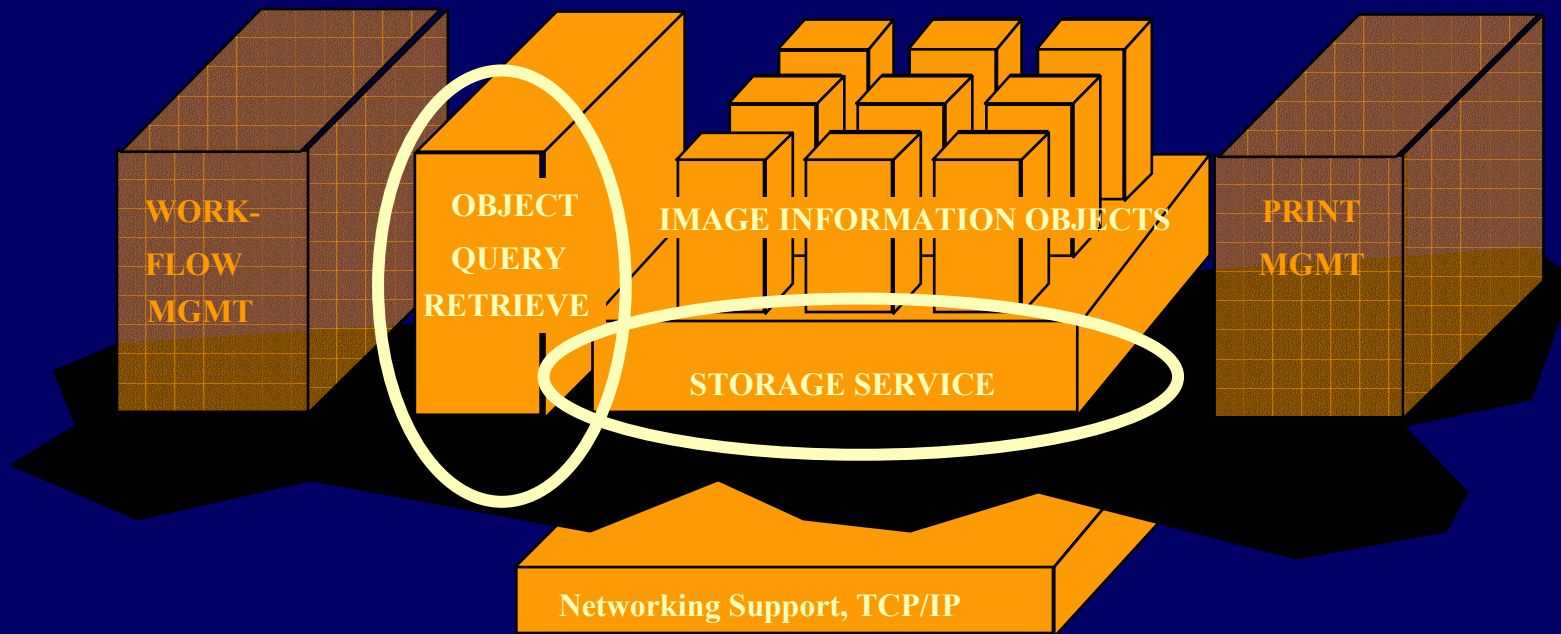
Non-Image Information Objects

- **Other types of modality data**
 - Waveforms: ECG, Hemodynamic, Electrophysiology, Audio
 - Spectroscopy
 - Radiotherapy: Plans, Treatment Records
- **Structured data**
 - Evidence Documents: Measurements, Analyses, Logs, CAD Results
 - Key Object Selection: Notes, Manifests
 - Structured Reports
- **Presentation controls**
 - Image Presentation States: Grayscale, Color, Blending
 - Inter-image Relationships: Spatial Registration, Fiducials, Stereometric

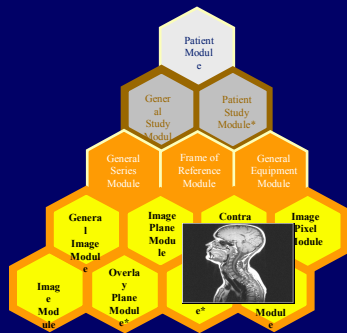
General term: *Composite* Information Objects

Almost as many non-image as image IODs!

DICOM for Image Transfer

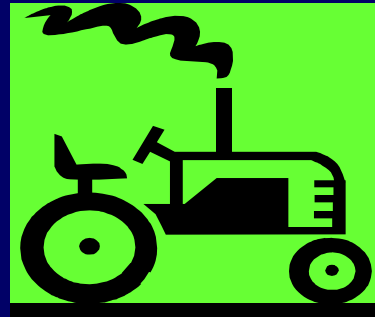


Service Object Pair (SOP) Class



**Image Info. Obj.
(the Data)**

+



**Store Command
(the Service)**

=



**DICOM
Communication
(SOP Class)**

- CR Image Storage SOP Class
- CT Image Storage SOP Class

Storage

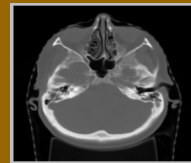
- **Send/Receive (i.e., push images on the network)**
- **SOP Class dependent on IOD**
 - CT, MR, US, CR, X-ray, Secondary Capture, RT, NM, Structured Report... (i.e. not only images)
- **How the SCP stores the image is not defined by DICOM (i.e., storage of all data not guaranteed)**
- **May send a study via multiple network associations (connections)**
- **May send more than one study on an association**

**DICOM does NOT define
a “one size fits all” image**

Storage Transfer – Push Images

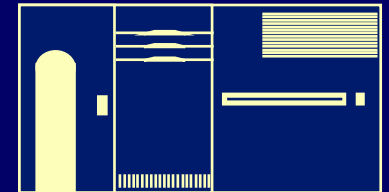
C-STORE-RQ ...

- C-STORE-RQ Command
- Image Header Data
(i.e. Name, ID, Row, Col..)
- Pixel Data



Digital Modality

Storage SCU



Shared Archive

Storage SCP

C-STORE-RSP...

-C-STORE-RSP Command (Status)

**Multiple transfers usually
occur on the same association**

Query/Retrieve

- Typically used by workstations for remote access and image retrieval from archives
- Simple queries such as - “give me the patient name and ID for studies performed today”
- Simple retrievals such as - “give me all images for Study XYZ”
- Based on information models
 - Patient model, Study model and Patient/Study only

Enables the “pulling” of images

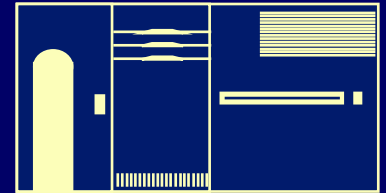
Query Remote Device



Workstation

C-FIND-RQ

-C-FIND-RQ Command
- Study=today, give me name/ID, etc.



Shared Archive

Query SCU

C-FIND-RSP

-C-FIND-RSP Command
(Pending Status)
- Study=Today, Joe Smith, 13456-7

Query SCP

C-FIND-RSP

-C-FIND-RSP Command
(Pending Status)
- Study=Today, Phil Jones, 2761-2

- Query remote database
- Pending rsp for each match
- One rsp for final status

C-FIND-RSP

-C-FIND-RSP Command
(Success Status)

Retrieve – Pull Images

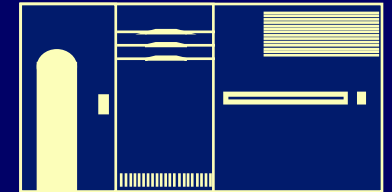


Workstation

Retrieve SCU

C-MOVE-RQ

-C-MOVE-RQ Command
- Study Inst UID for images to pull.



Shared Archive

Retrieve SCP

C-STORE-RQ *Separate association from C-Move*

C-STORE-RSP

(Typically for Multiple Images)

Same association as C-Move-RQ

C-MOVE-RSP

-C-MOVE-RSP Command (Status)

- Request Move “Pull” of images
- Archive opens second association to send images
(the roles change for storage)
- Response on same association as C-Move-RQ

Three Device Move

Retrieve SCU



Workstation A

C-MOVE-RQ

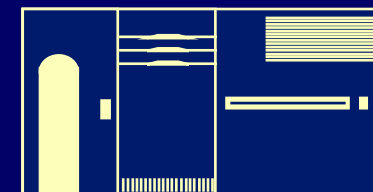


After the image transfer completed

C-MOVE-RSP



Retrieve SCP



Shared Archive

C-STORE-RQ



Workstation B

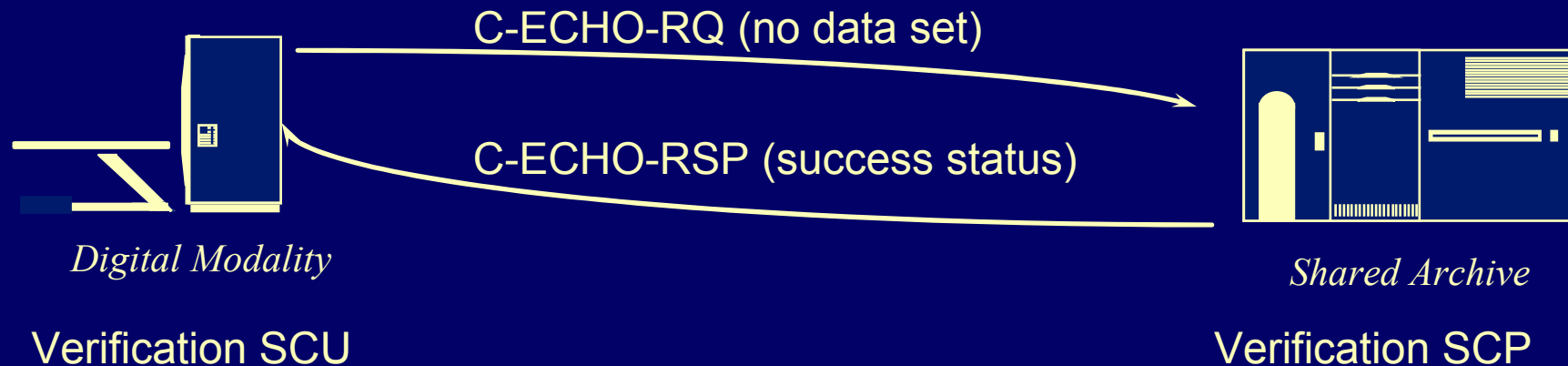
Storage SCP

C-STORE-RSP

- A requests the Move of images to B
- Archive opens second association to B
- Archive sends images to B then closes assoc
- Association between A and archive open during image transfer
- Archive provides final Move-RSP status to A
- All Retrieve SCPs required to support the Three Device Move

Verification

- “Echo” to verify application level communication between two DICOM products
- Often used for service diagnostics to determine if another product is on-line or off-line
- Products that accept DICOM associations are required to support Verification as an SCP



Compression and Transfer Syntaxes

- **DICOM treats image compression as a separate run-time negotiable aspect of image transfer**
 - SCU and SCP agree on acceptable combinations of SOP Class and compression transfer syntax
 - Rules for default transfer syntax
- **Currently approved compression transfer syntaxes:**
 - JPEG Lossless
 - JPEG Lossy (8-bit and 12-bit)
 - JPEG-LS Lossless
 - JPEG-LS Lossy (Near-Lossless)
 - JPEG 2000 Lossless
 - JPEG 2000 Lossy
 - JPEG 2000 Part 2 Multi-component Lossless**
 - JPEG 2000 Part 2 Multi-component Lossy**
 - MPEG2 MP@ML
 - Run Length Encoding (Lossless)
 - Deflate (ZIP - Lossless)

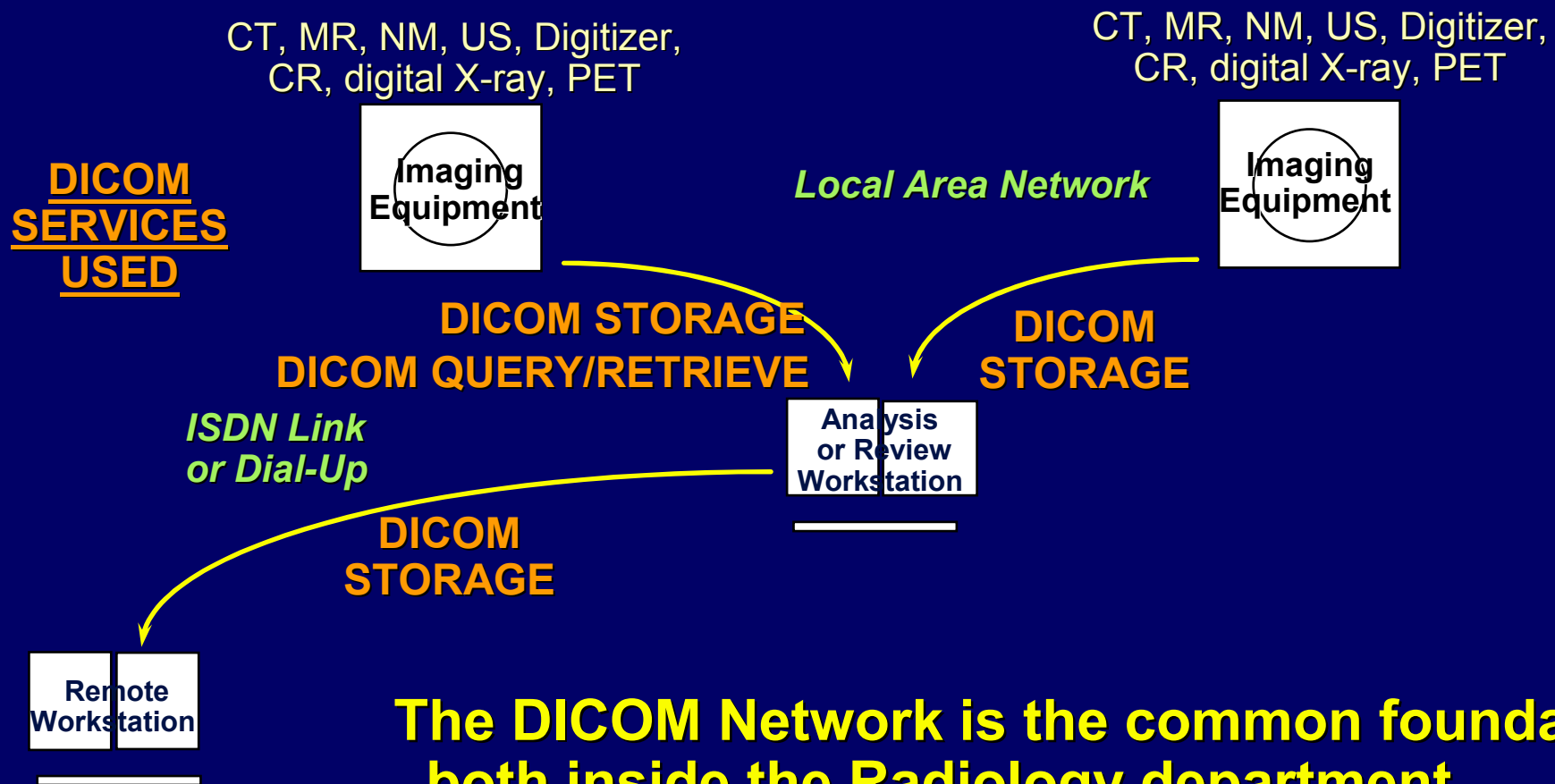


What should I do to build a DICOM Image Transfer Network ?

Three Steps:

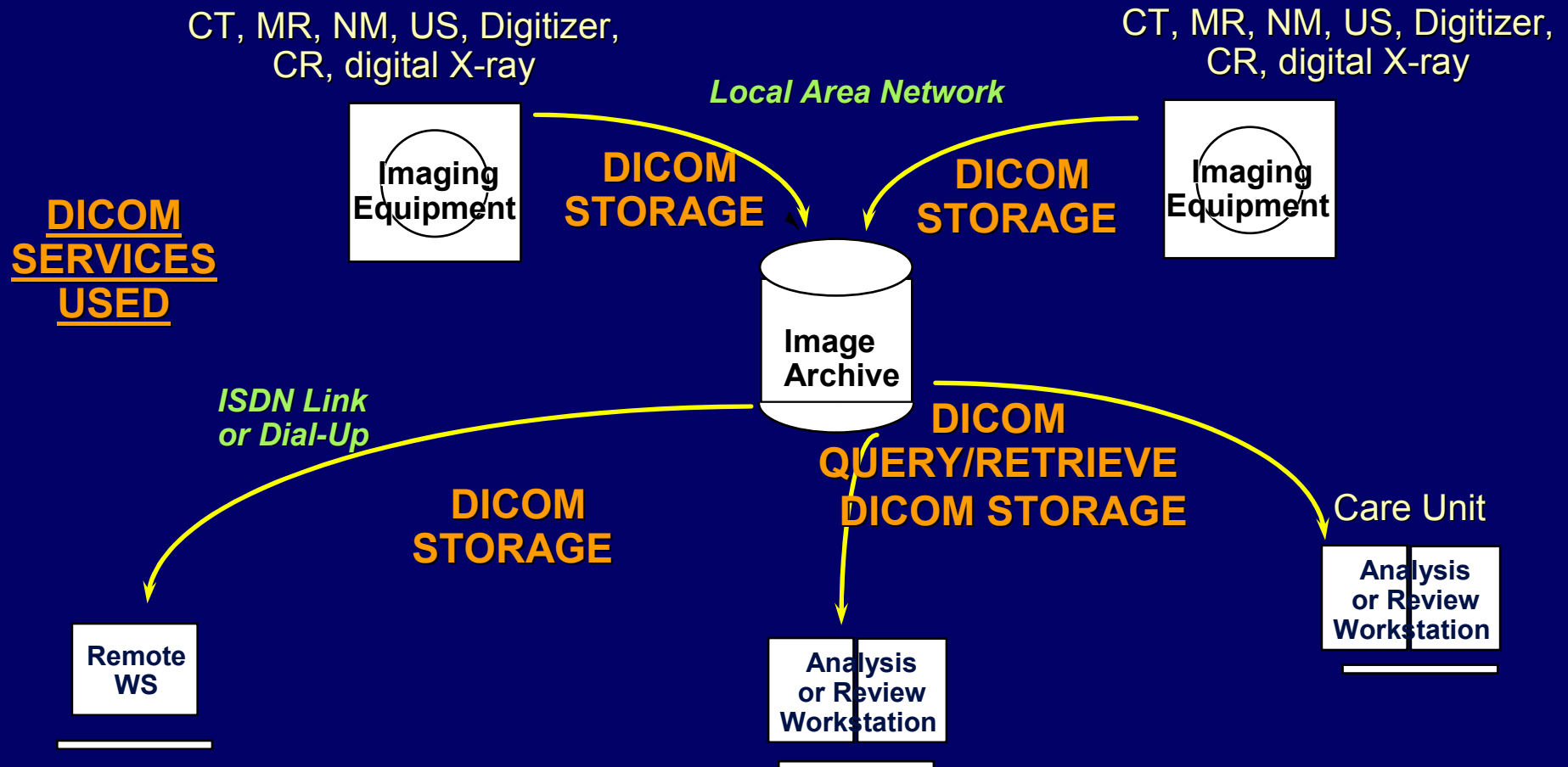
- 1 - Clarify my Clinical Needs for Image Transfer and Image Processing Applications
- 2 - Match Those Needs with DICOM Service Classes using the DICOM Conformance Statements
- 3 - Validate the Imaging Application Interoperability

Simple Networks in Radiology and Teleradiology



The DICOM Network is the common foundation both inside the Radiology department and for Teleradiology

Networks in Radiology and Care Units with Central Archiving



Step 2 - Compare DICOM Conformance Statements

CT Scanner Conformance Statement



1-CT STORAGE SCU

2-QUERY SCP

3-RETRIEVE SCP

4-MODALITY WORKLIST SCU

SCU = Service Class USER

SCP = Service Class PROVIDER

Workstation Conformance Statement



1-CT STORAGE SCP

2-QUERY SCU

3-RETRIEVE SCU

4-MR STORAGE SCP

5- BASIC PRINT SCU

Matching DICOM Service Classes
The necessary step to find what will work

Conformance Statement Matching

- **SOP Classes – fundamental**
- **Transfer Syntaxes – essential if you want to use compression**
 - Used extensively in Ultrasound
- **Supported Query Keys – ensure you can find what you are looking for**
 - Note: IHE has specified an expanded set of query keys (beyond the default minimum) to facilitate robust operation

WHERE WE ARE NOW

- **After 12 years, DICOM is universally accepted as the only global standard for medical image exchange**
- **On-site installation of DICOM image transfer is nearly plug-and-play (aside from address set-up – and we're working on that!)**
- **DICOM has established the market for PACS and digital imaging**