



GE Medical Systems

The Basic Structure of DICOM

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SSRPM Course – Neuchâtel – June 2003

DICOM...



Is a **GLOBAL STANDARD** of Communication,
developed under joint efforts by
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 (Deutschen 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 3.0 approved October '93**

- **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 to count !

DICOM documents updated yearly

DICOM 2003 is a compatible extension of DICOM 2001
+ 27 Clarifications/Changes + 3 Supplements

Available from Global Engineering Documents:
<http://global.ihs.com>

or

Free on the web : <http://medical.nema.org/dicom.html>

DICOM 3.0, DICOM 96, DICOM 98, DICOM 99, DICOM 2000,
DICOM 2001, DICOM 2003
are only document publishing names.

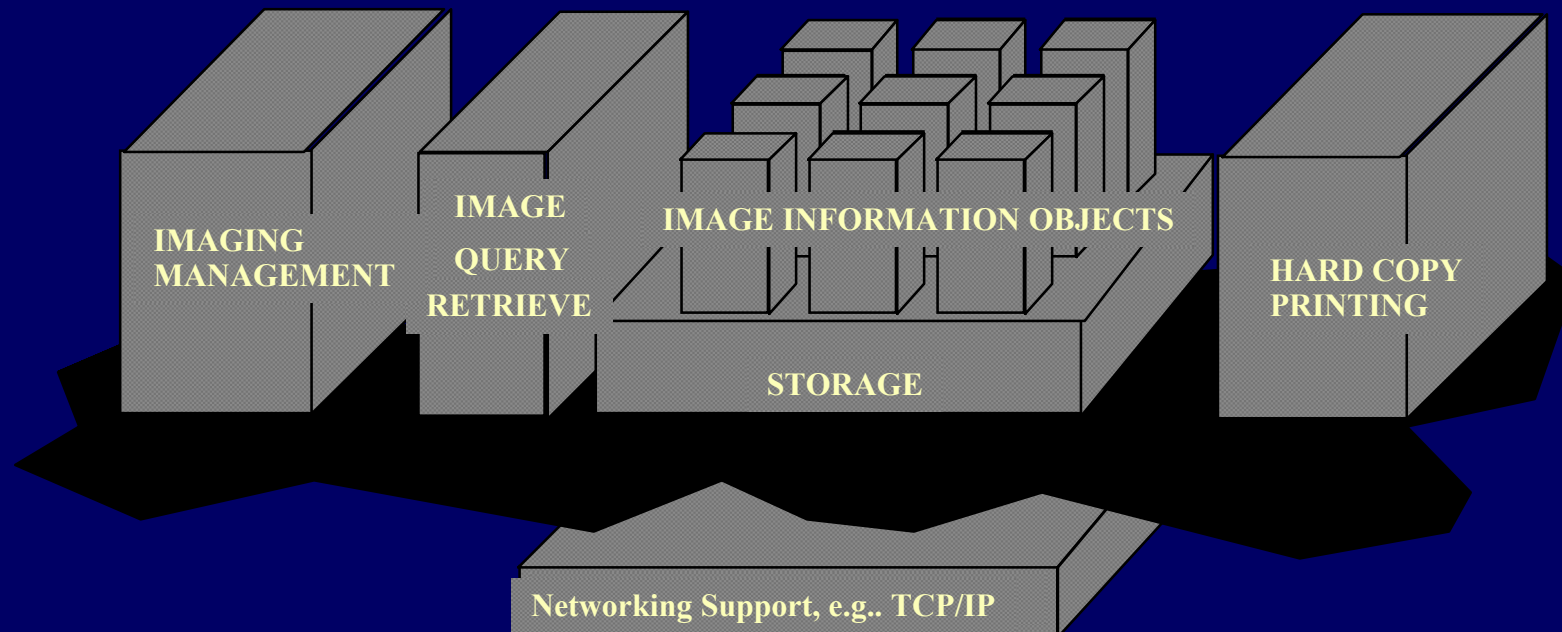
***This has no direct impact on existing
Product Conformance !***

The 4 dimensions of DICOM

DICOM for
Image Management

DICOM for
Network Image Transfer

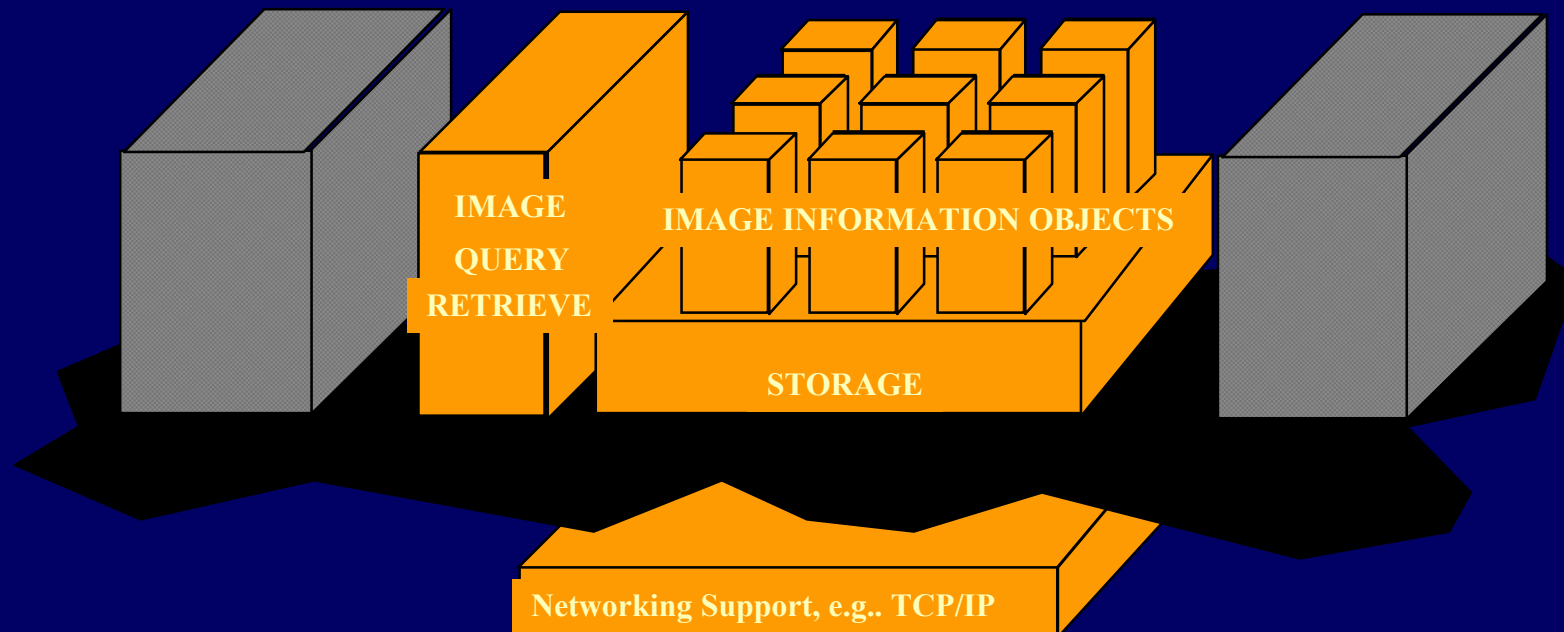
DICOM for
Network Printing



and ... DICOM for Media Interchange/Archiving

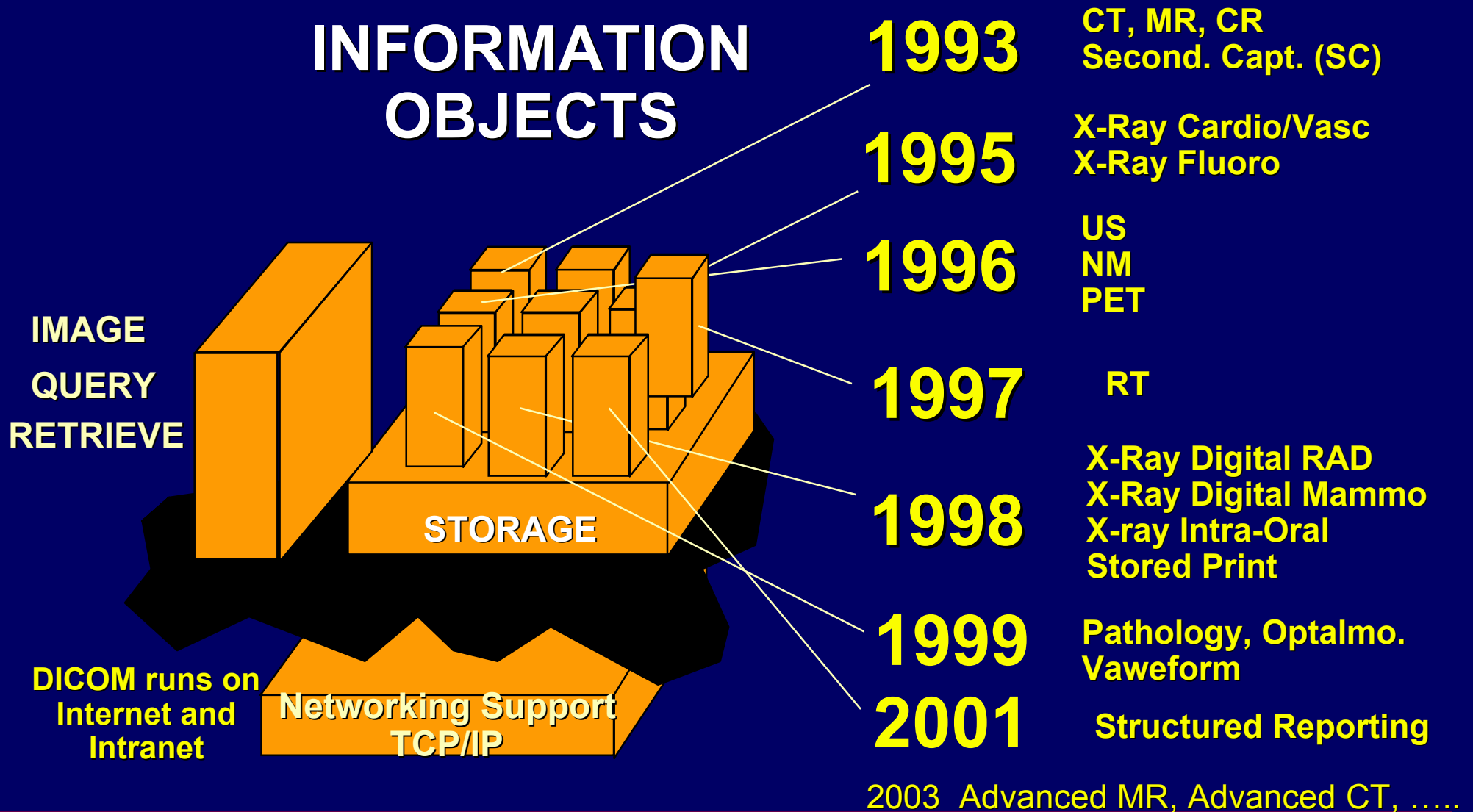
Dimensions #1

DICOM for Image Transfer



Understanding Image transfer with DICOM ...

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 Reports

DICOM transfers not only Radiology images, but also:

- Cardiology (X-Ray Angio, US, NM)
- Oncology (RT Portal images)
- Dentistry (X-ray Intra-Oral)
- Pathology, Endoscopy, Microscopy, Optalmology, etc.

1993

CT, MR, CR
Second. Capt. (SC)

1995

X-Ray Cardio/Vasc
X-Ray Fluoro

1996

US
NM
PET

1997

RT

1998

X-Ray Digital RAD
X-Ray Digital Mammo
X-ray Intra-Oral
Stored Print

1999

Pathology, Optalmo.
Vaweform

2001

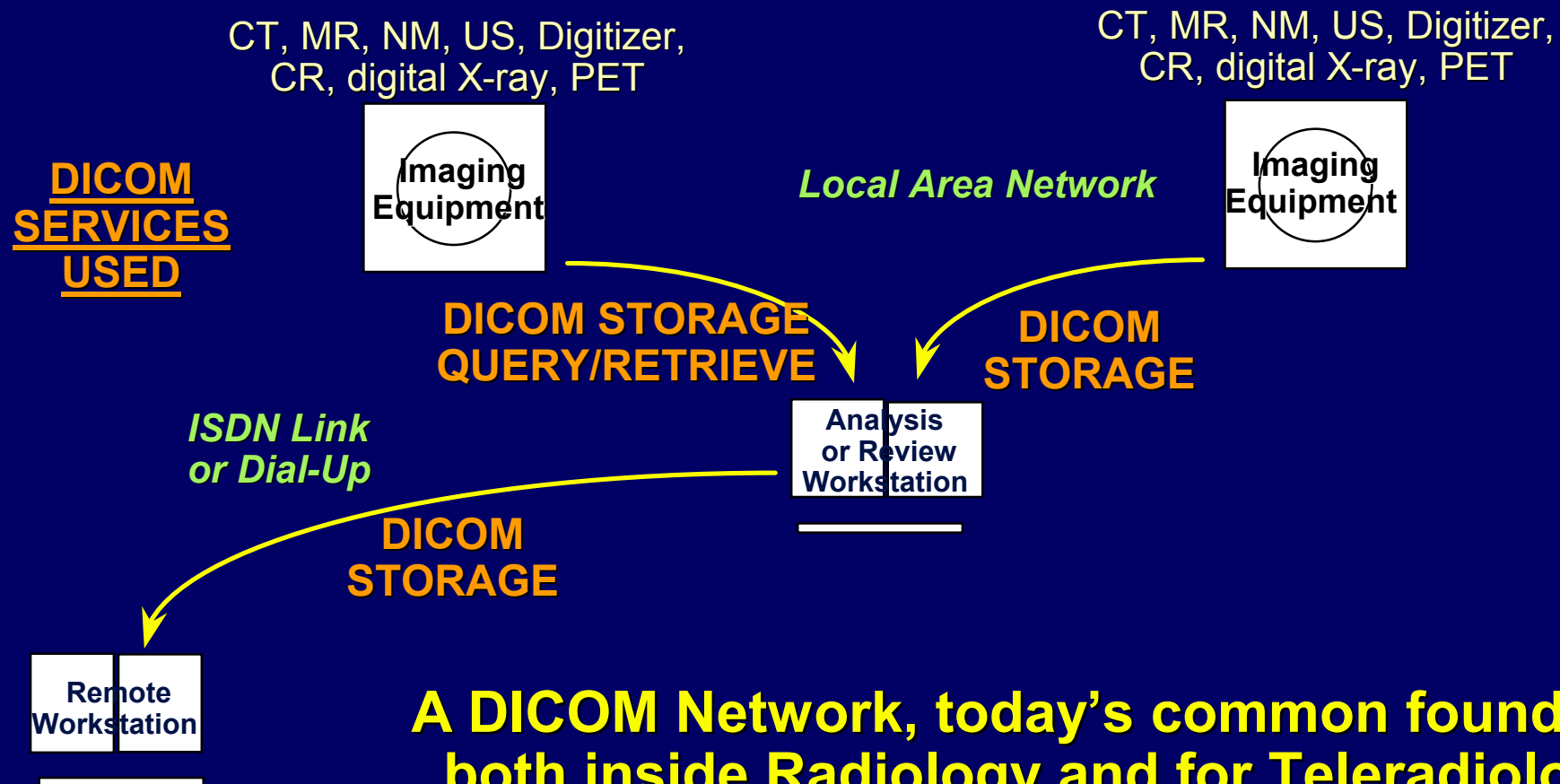
Structured Reporting

2003 Advanced MR, Advanced CT,

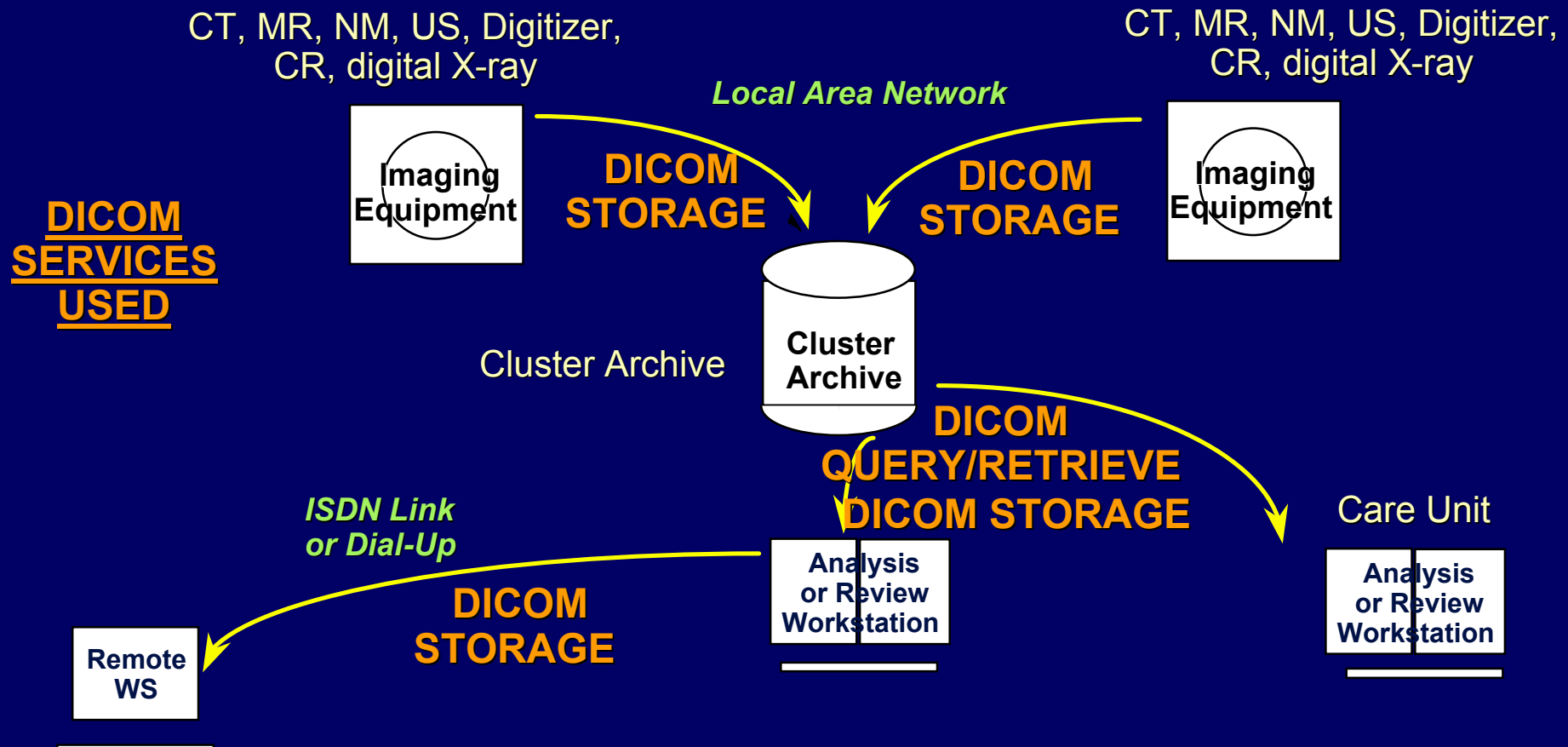
What can I really do with DICOM TODAY ?

- **Build simple and easy-to-implement networks**
- **Reap efficiency and productivity benefits**
- **Invest in a necessary step for future PACS**

Simple Networks in Radiology and Teleradiology



Networks in Radiology and Care Units with Cluster Archiving



**A DICOM Network is the common foundation both
inside Radiology and for Teleradiology**

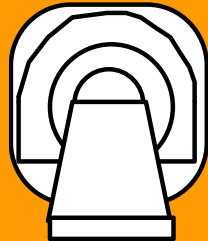
What should I do to build a DICOM Image Transfer Network ?

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

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

DICOM: Service-Object Pair

Example: CT Image Storage

Service: "Store"

Object: "CT Image"

SOP Class "Store CT Image"

Generic Sentence:

Unique ID: 1.2.840.10008.5.1.4.1.1.2

SOP Instance "Store this CT Image"

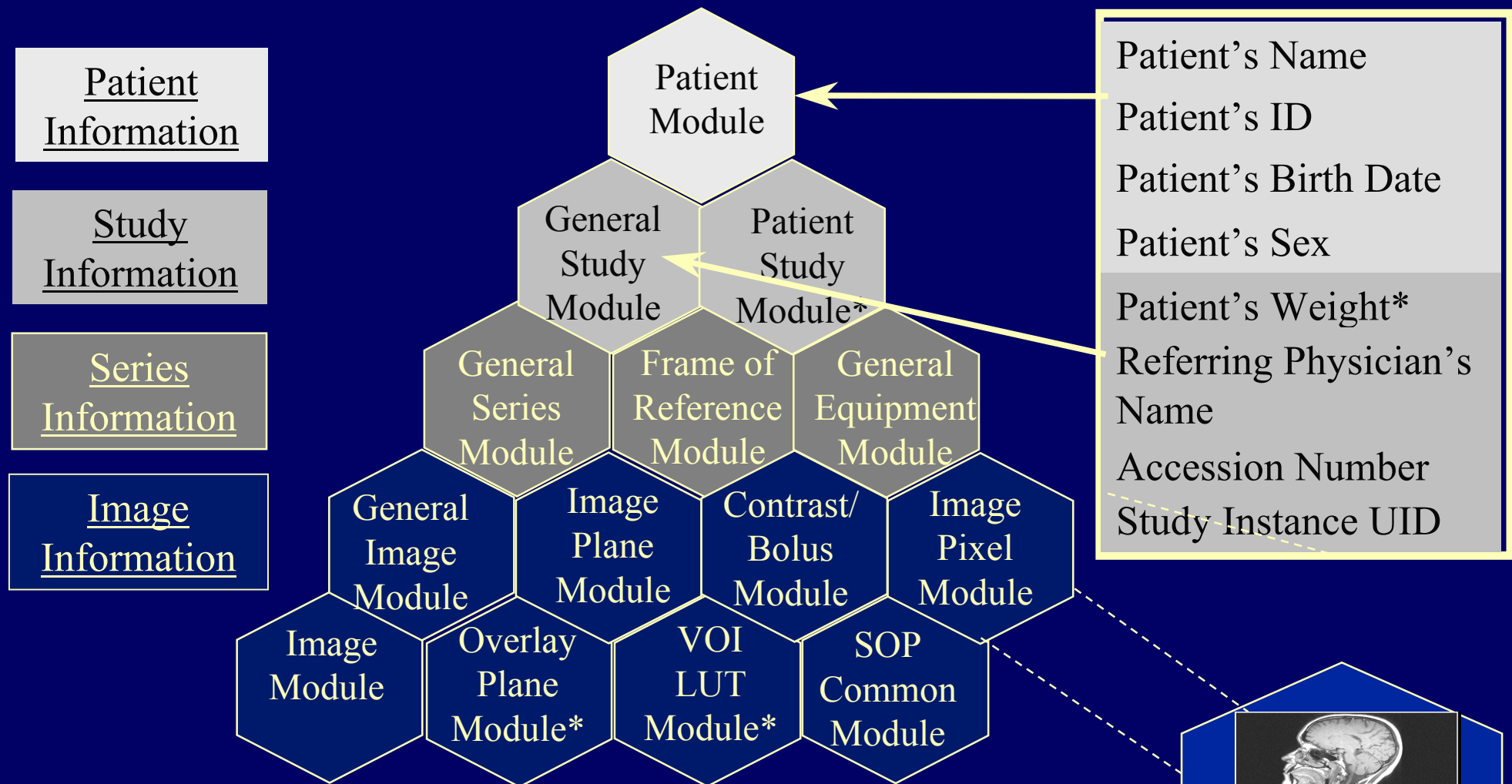
Specific Sentence (SOP Instance): Absolutely unique instance !

Unique ID: 1.2.840.113619.3.23.1584567.4465.123.19.2

In practice, how does it work...

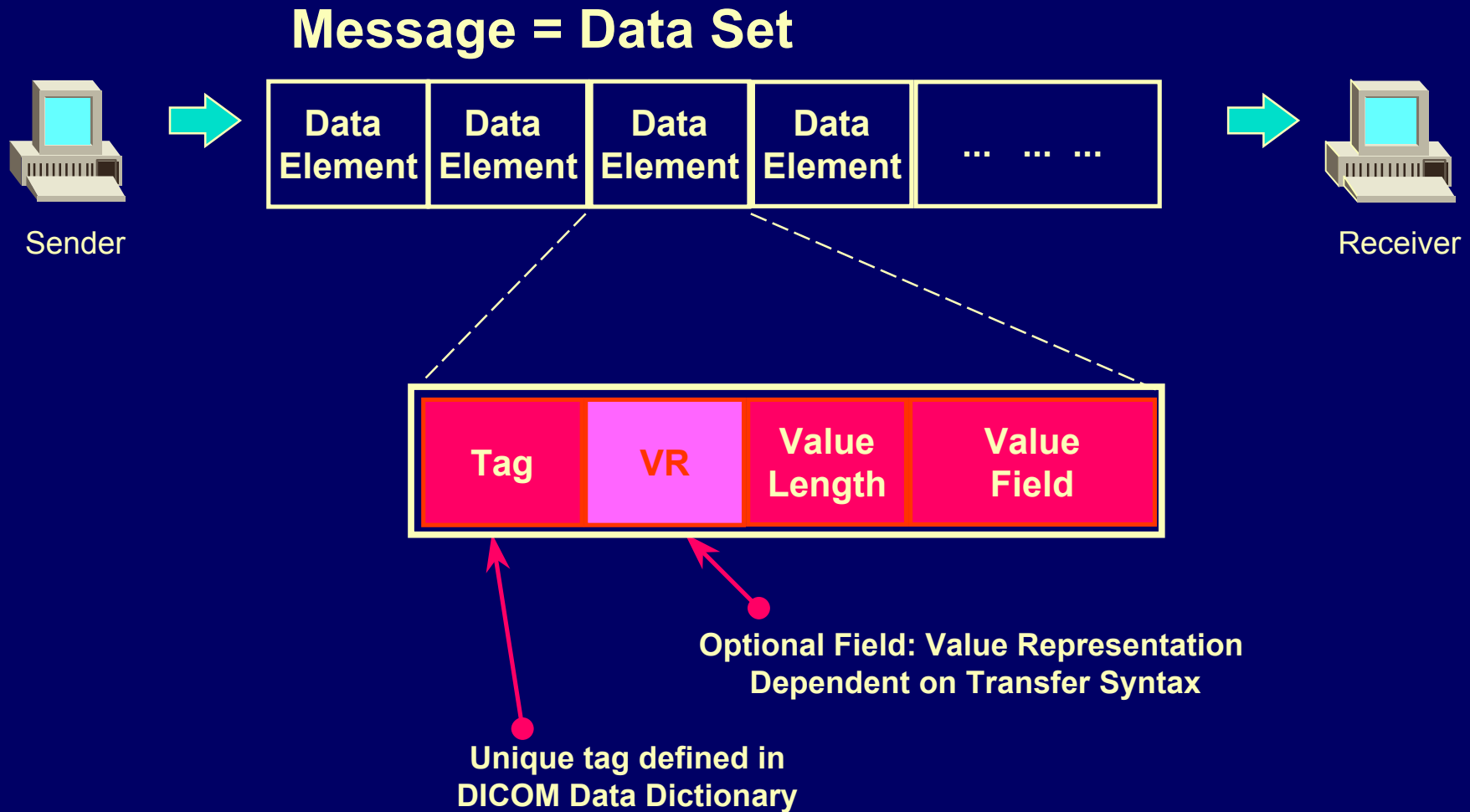


Image Information Object Definitions (IOD)



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

DICOM Encoding



Great, So it will simply Plug and Play ?

Do not Forget Step 3 !

1 - Clarify my Clinical Needs for Image Transfer and Image processing Applications

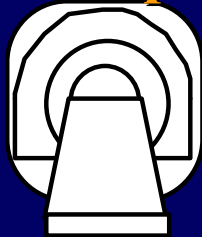
2 - Match Those Needs with DICOM Service Classes using the DICOM Conformance Statements

3 - Validate the Imaging Application Interoperability

Step 3 - Application Interoperability(1)

CT Scanner

Conformance Statement
CT Object Implementation



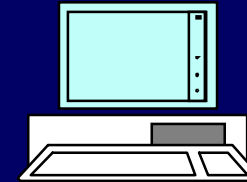
Private
Attributes

Optional
Attributes

**REQUIRED
DICOM Attributes**

3D Application

Conformance Statement
CT Object Requirements



**Application required
DICOM Attributes**

**DICOM Addresses Plug and Play Only for
Applications with Basic Information Requirements**

Step 3 - Application Interoperability(2)

MR Scanner
Conformance Statement
MR Image Object Implementation

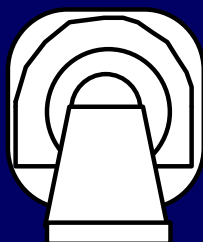
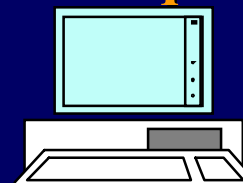


Image Filtering Application
Conformance Statement
MR Object Requirements



**Private
Attributes**

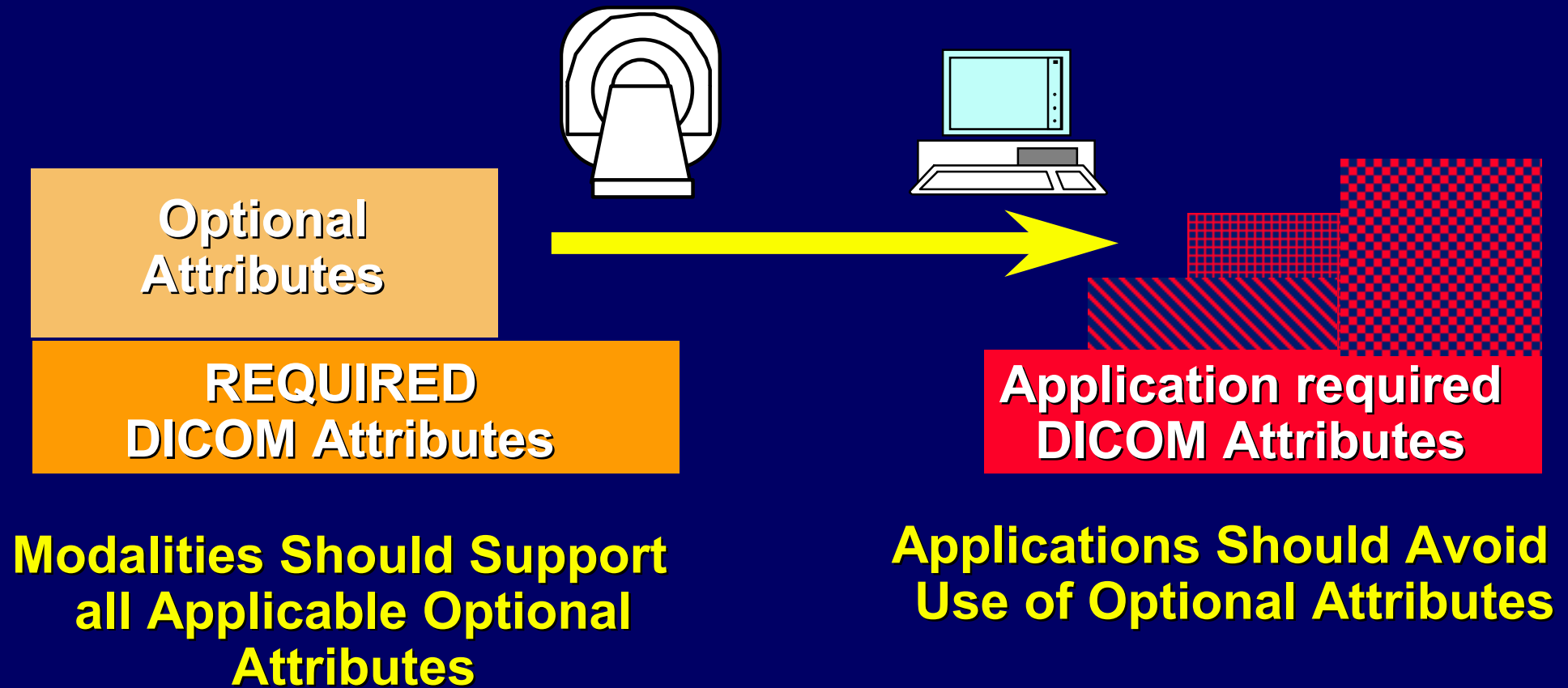
**REQUIRED
DICOM Attributes**

**Application required
DICOM Attributes**

**Applications with Complex Information Requirements
May not be Plug and Play**

Step 3 - Application Interoperability(3)

To Maximize Application Interoperability



So What Should Be Done ?

1 - Fix the Standard ?

No, The Standard has to strike the proper balance between:

- Plug and Play
- Variety of Modality and Applications
- Innovation and Need for New Attributes

==> Document in the Conformance Statements Attributes Support

2 - Application Interoperability can Be Maximized (Previous Slide)

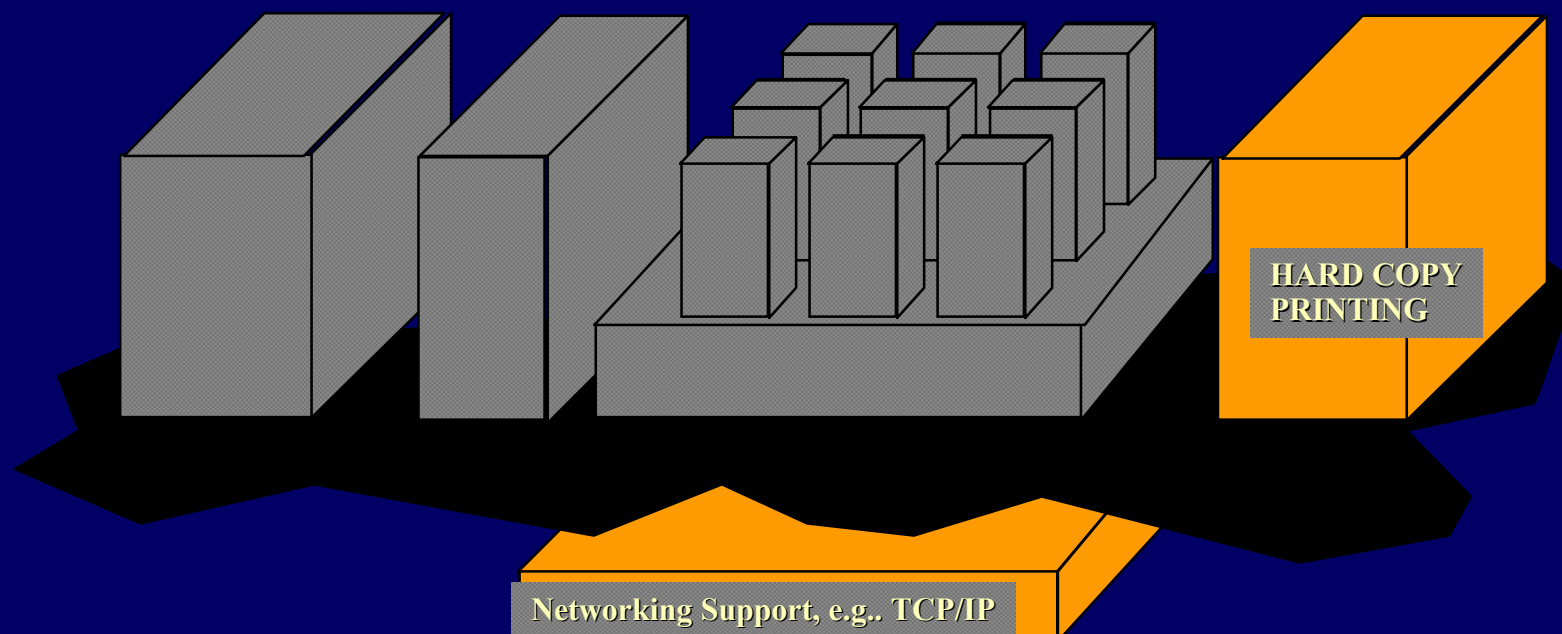
==> Select Products With Good Design.

3 - In the (few) Cases Imaging Application Use Complex Attributes:

==> Interoperability Should be Carefully Analyzed (Conformance Statements) and Validated in Clinical Environment.

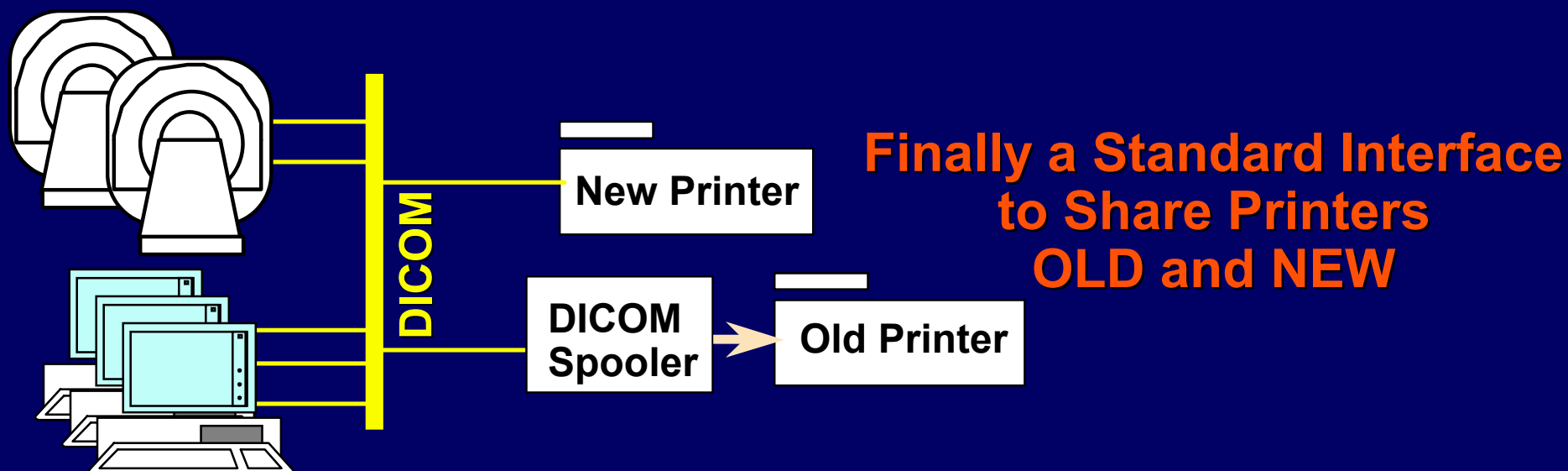
Dimensions #2

DICOM for Network Printing



Understanding Film Printing with DICOM ...

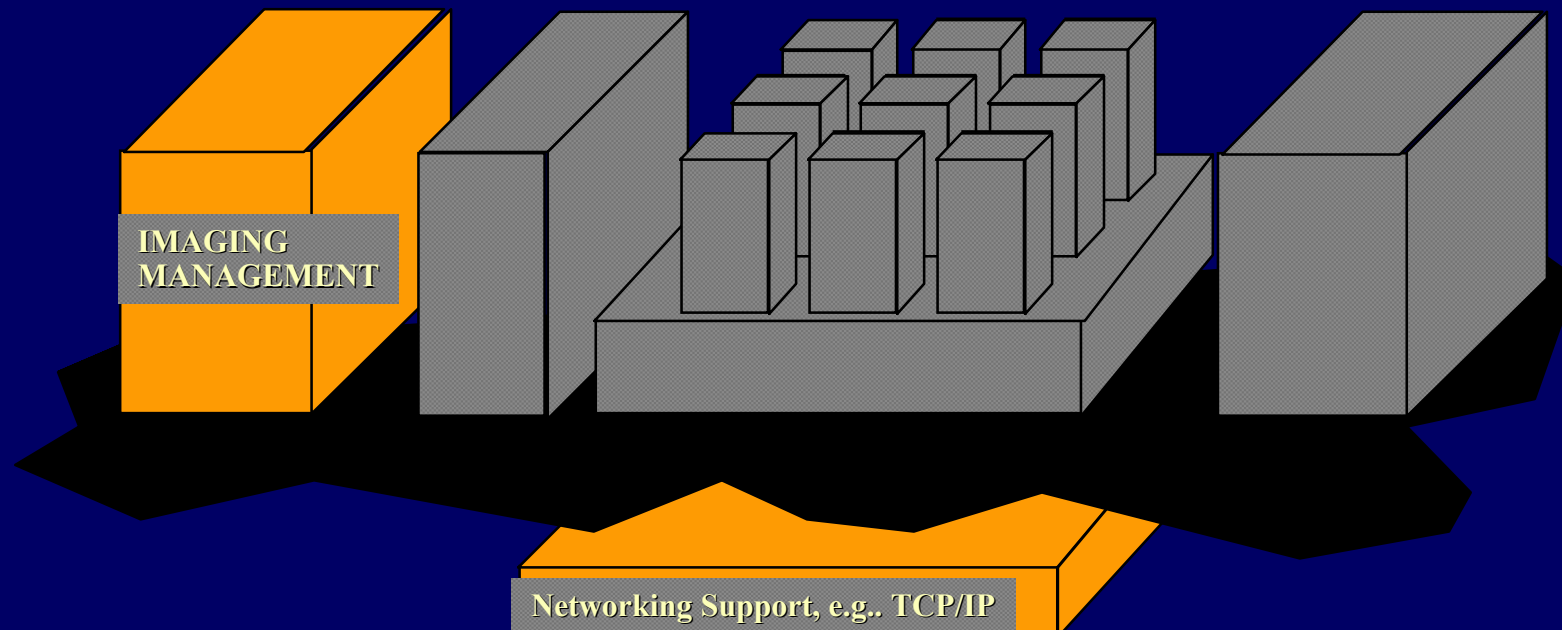
DICOM Print Management today



- **DICOM print (Grayscale and/or color) links Cameras with Workstations and Modalities on a standard network**
- **All necessary Features available for digital hardcopy devices.**
- **Print Consistency (Print Presentation LUT) becoming available**

Dimensions #3

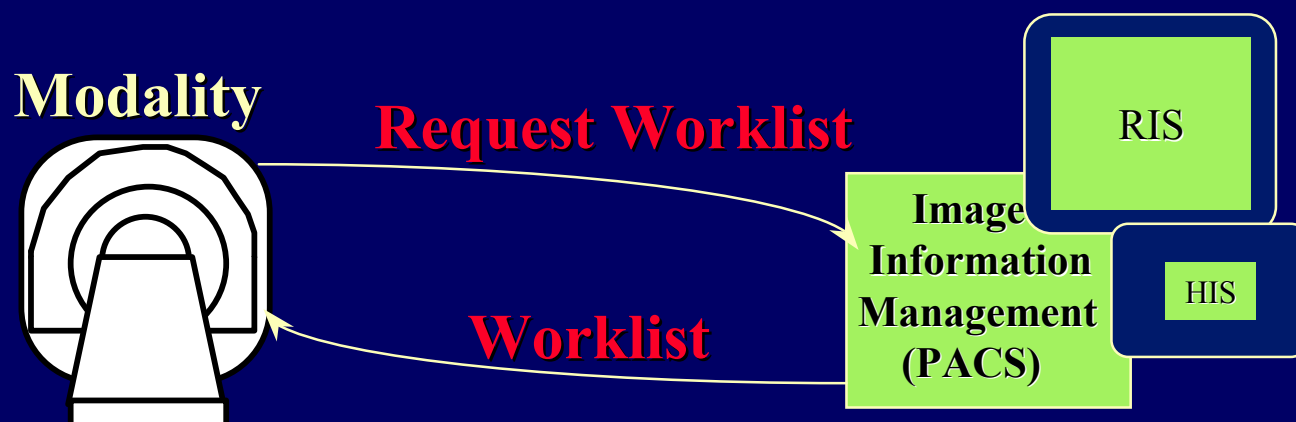
DICOM for Imaging management



Understanding Information Management with DICOM ...

DICOM Modality Worklist

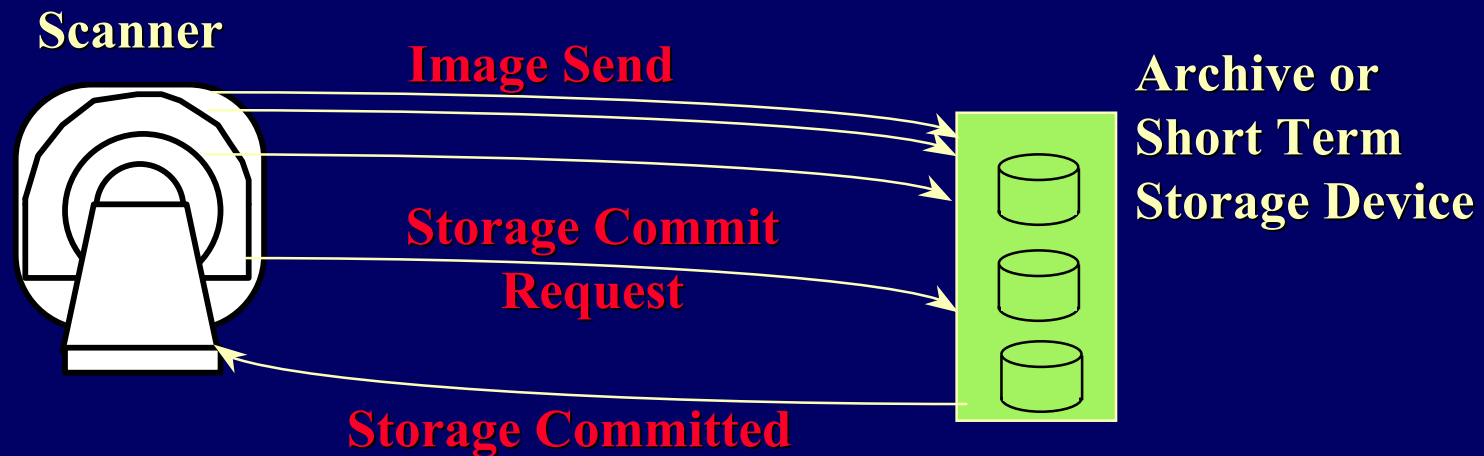
- Provides integration of modalities with Radiology Information Systems and PACS
- Automatic download of patient demographics, study identifiers, scheduling, procedure into a modality.



Increases operator productivity and avoids typing errors
First Products available since 1997, Broad Availability in 1999

DICOM Storage Commitment

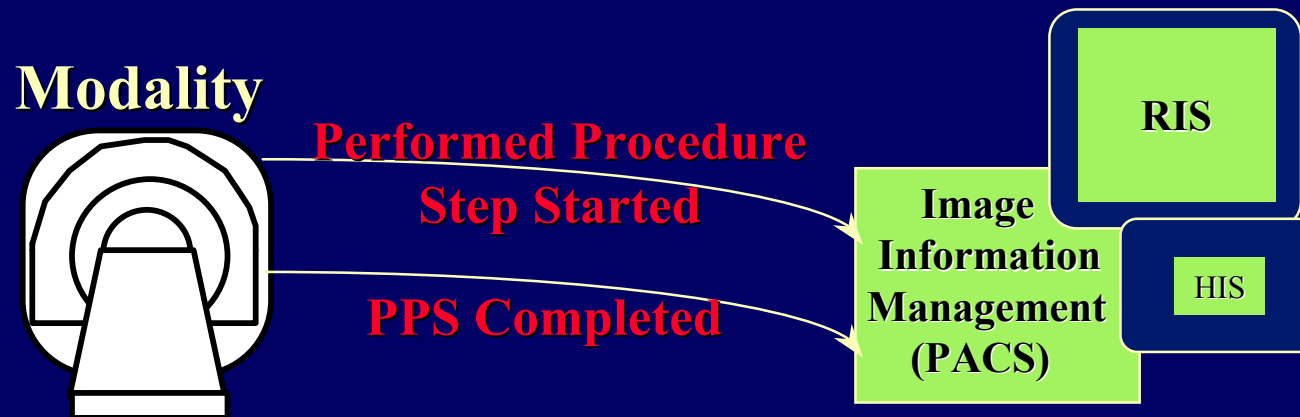
- Enables an image source to obtain the commitment that images have been stored for safekeeping.
- Modality image deletion is only allowed if storage has been committed



Products broad availability since 2001

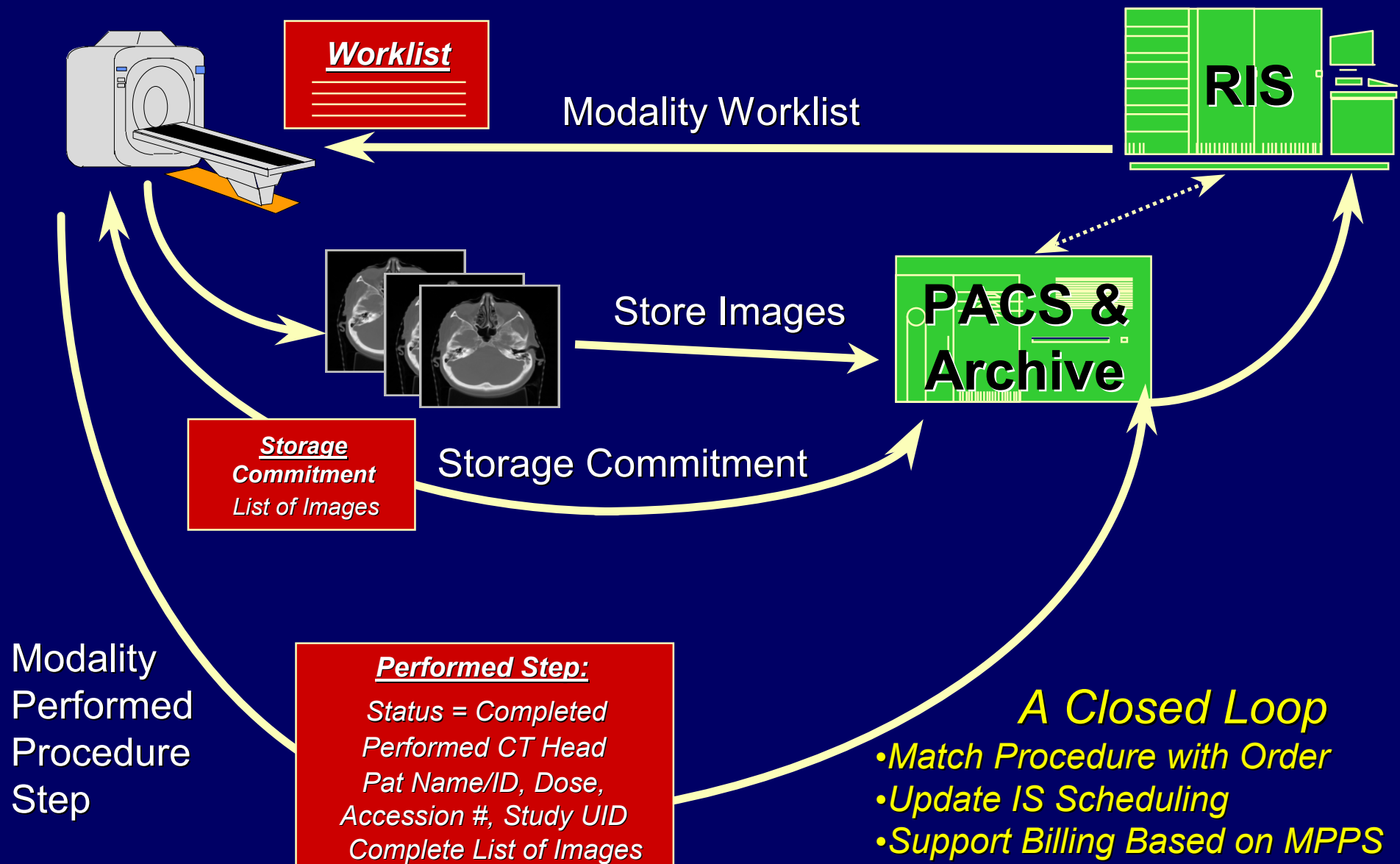
DICOM Performed Procedure Step

- Allows Modalities to Upload in HIS/RIS/PACS of Acquisition Administrative Data (Proc. Started/Complete, Contrast, Dose, etc.).
- Complement to Modality W/L. Increases Overall Radiology Department Productivity.



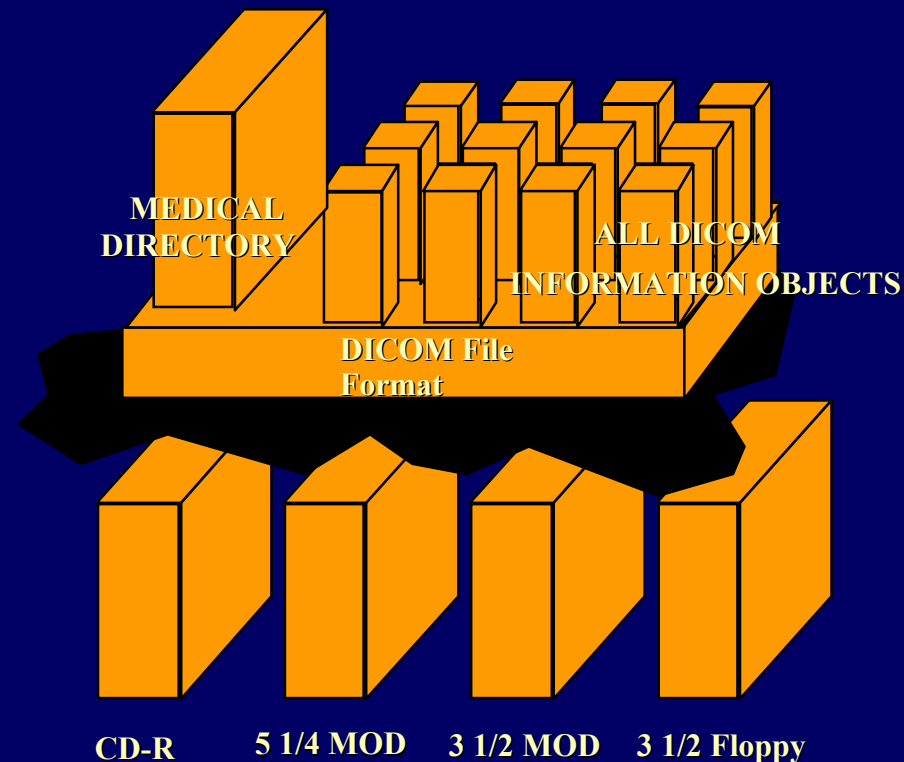
First products introduced in 2001
Broad availability in 2003

4 DICOM Service Classes for Integration



Dimensions #4

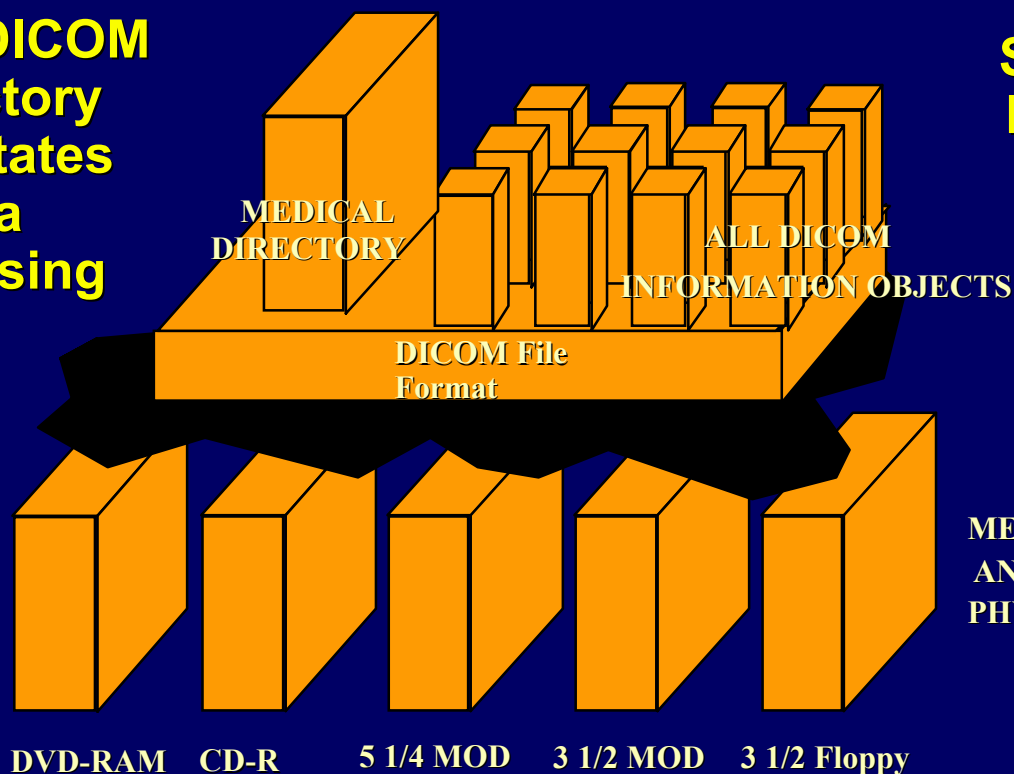
DICOM for Media Interchange/Archive



Carrying DICOM Images Stored on Media ...

Media Interchange Too !Since 1996 !

The DICOM Directory facilitates media browsing



Same Image Objects on Media and on the Network

DICOM defines a generic File Format

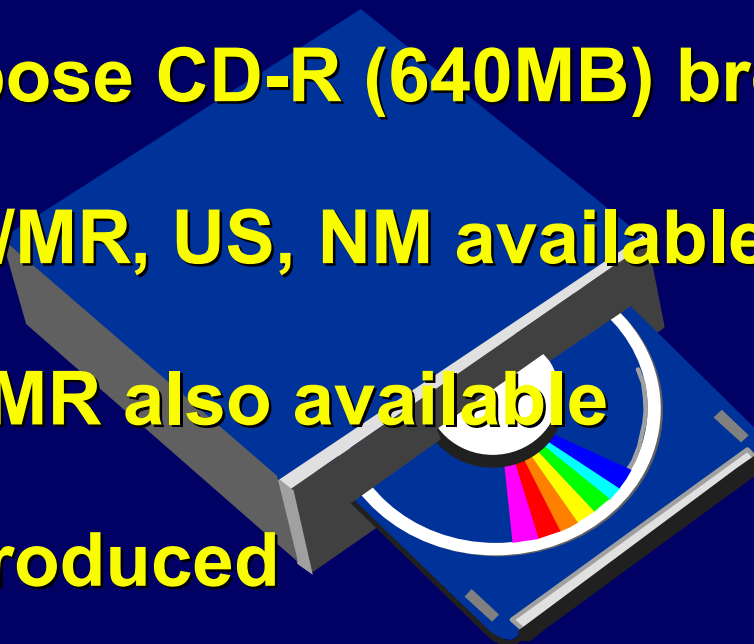
MEDIA FORMAT AND PHYSICAL MEDIA

DICOM Relies on Broadly Available Media Storage Technology

DICOM MEDIA STORAGE

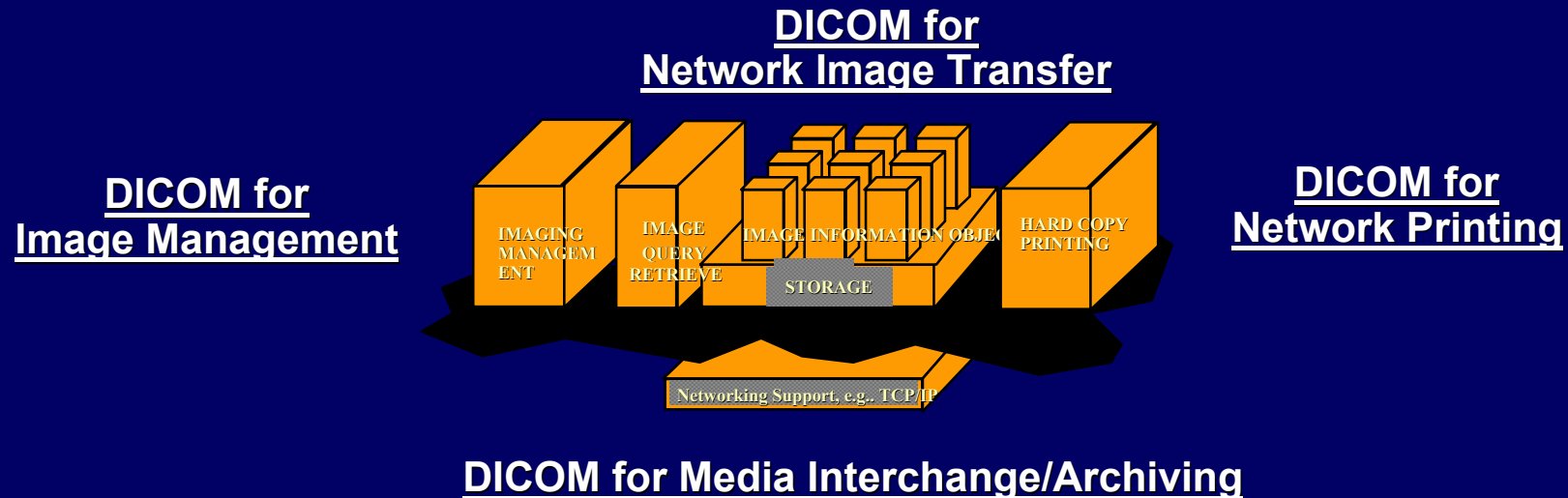
Open and Flexible Media

- Cardiac DICOM CD-R broadly used
- General Purpose CD-R (640MB) broadly used
- MODs for CT/MR, US, NM available
- CD-R for CT/MR also available
- DVD Now introduced



**DICOM General Purpose CD-R, the film substitute.
Even given to patients !**

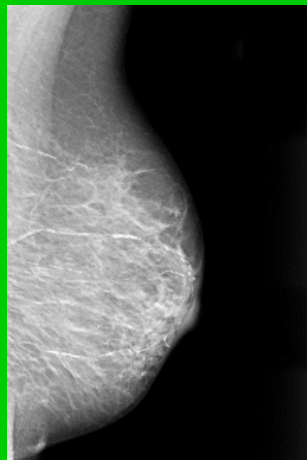
Dimensions #5



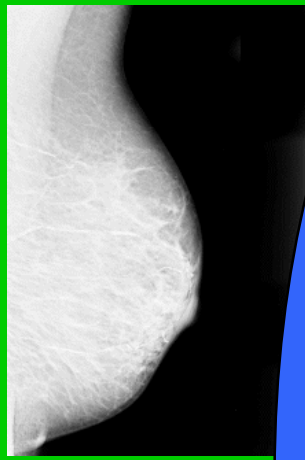
and soon DICOM for Image Display Consistency...

Image Consistency critical for other Departments

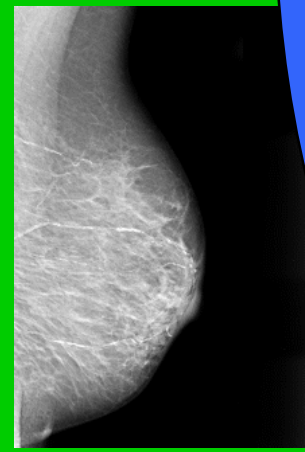
Imaging Department



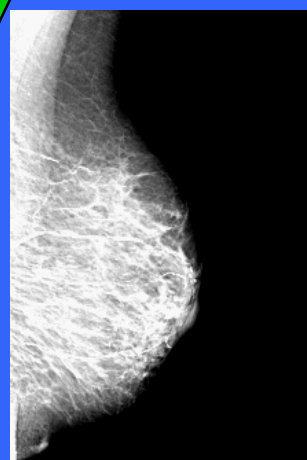
Acquire



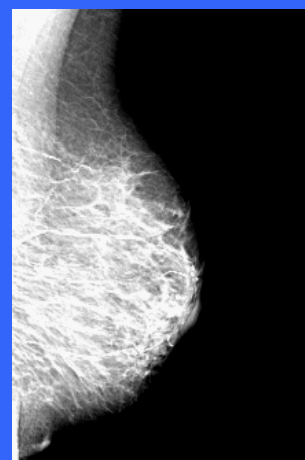
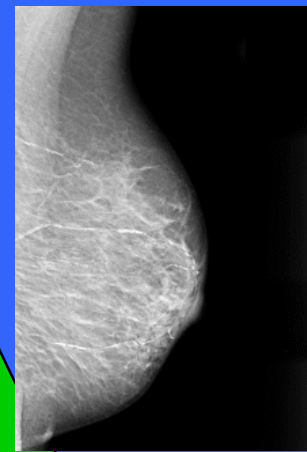
Display



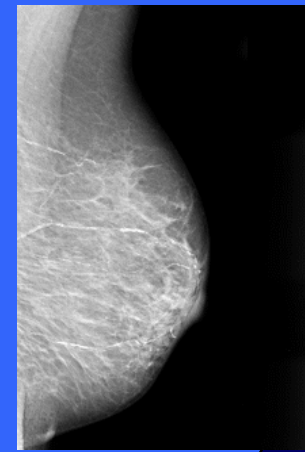
Other Department



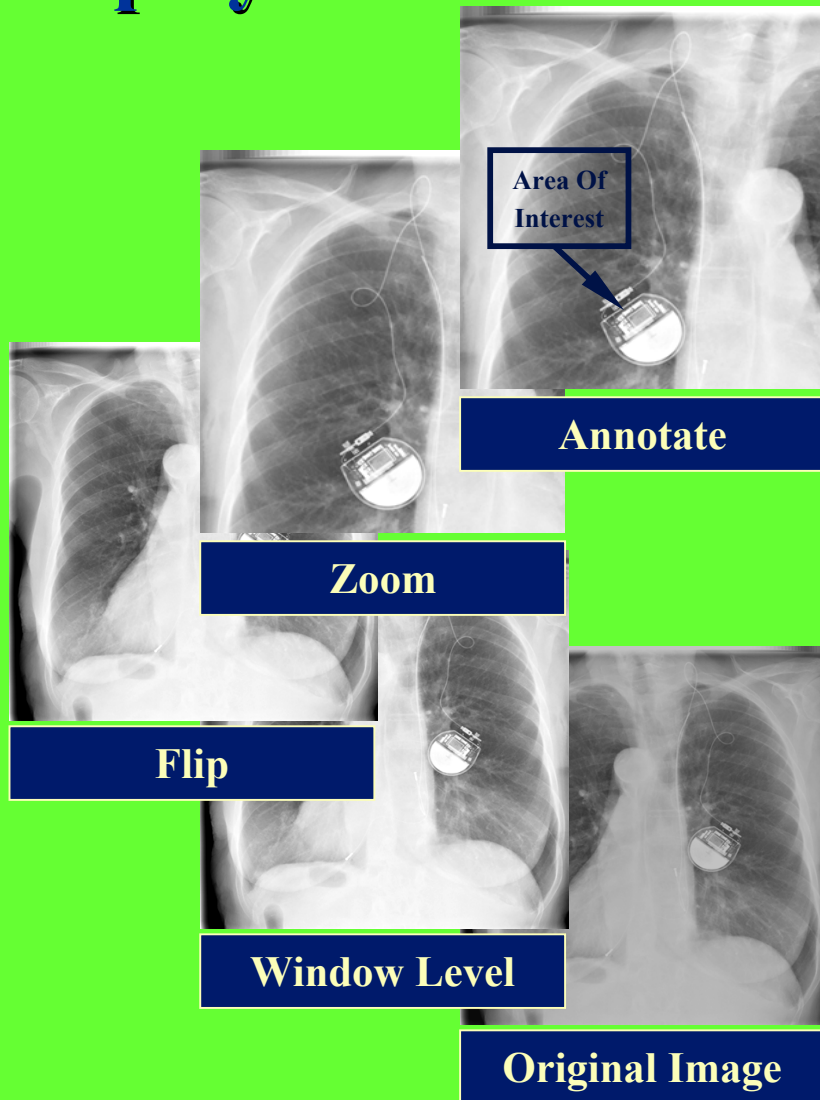
Print



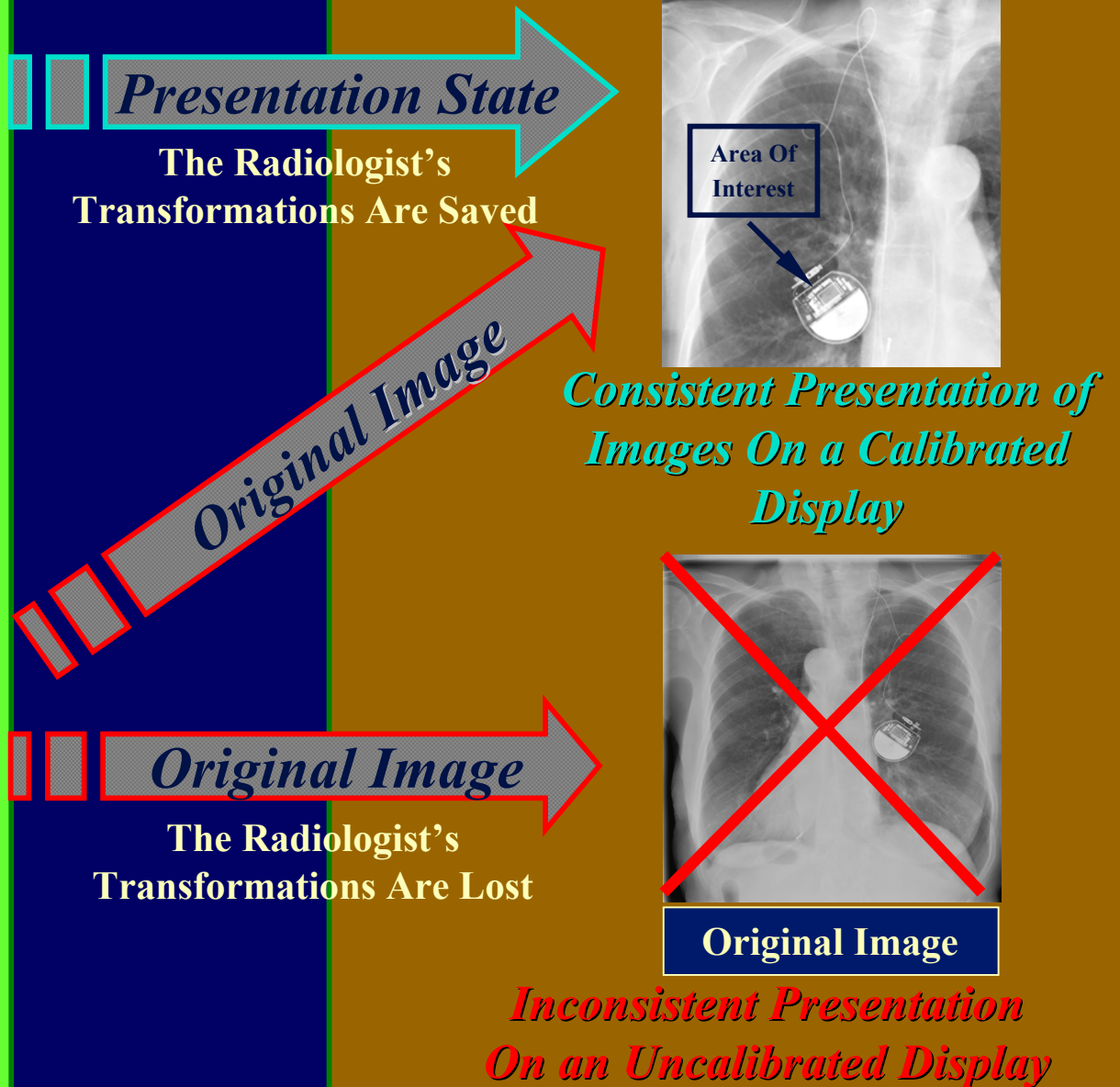
Review (Web)



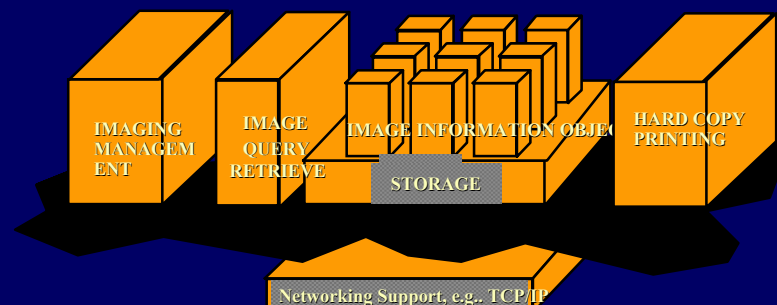
What the Radiologist Displays:



What the Reviewing Physician Sees:



DICOM Implementation



DICOM Experience.....

.....and DICOM in Products

DICOM in '03 - An Alive and Growing Standard

- **JPEG 2000 for better Lossless/Lossy adopted.**
- **DICOM reaches well beyond Radiology. It is in Cardiology, Radiotherapy and enters Pathology, Gastroenterology, Ophthalmology and Vital Signs.**
- **New Objects are under definition for advanced MR, Advanced CT, VL Movies(MPEG2).**
- **Reporting is a growing area of focus. A Reporting object and key object selection has been approved.**
- **Security is addressed (Node Authentication and Encryption done, Signature approved).**
- **DICOM is looking outwards for integration with other emerging and complementary healthcare standards HL7, and Internet.**

DICOM is growing, improving and here to stay

Experience with DICOM

- All vendors committed to DICOM support (e.g. >80 products are offered by GE with DICOM support).
- Probably difficult to find a hospital in America, Europe, Asia without at least one imaging system with DICOM. Most use DICOM every day, thousand of times.
- Conformance statements are available from most vendors through Internet (e.g. for GE at: ge.com/dicom).
- Supports cross-vendor testing. Vendors cooperation results in issue analysis.
- DICOM is an internationally accepted standard.

Thank You !

charles . parisot @ med . ge . com

**GE DICOM Conformance Statements:
ge . com / dicom**