Standardization of diagnostic images

- How DICOM works with Dental -

Japan Industries Association of Radiological Systems (JIRA)
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preface

- This presentation is made to introduce
  - the basics of DICOM Standard which is already a de-facto standard in medical imaging industry.
  - how standards help you work smoothly in your environment.
  - Some other guidelines to standardize your work environment.

Acknowledgement

Some of Dental images were provided by

Mr. Yamamoto of Osaka University.

contents

1) What DICOM defines

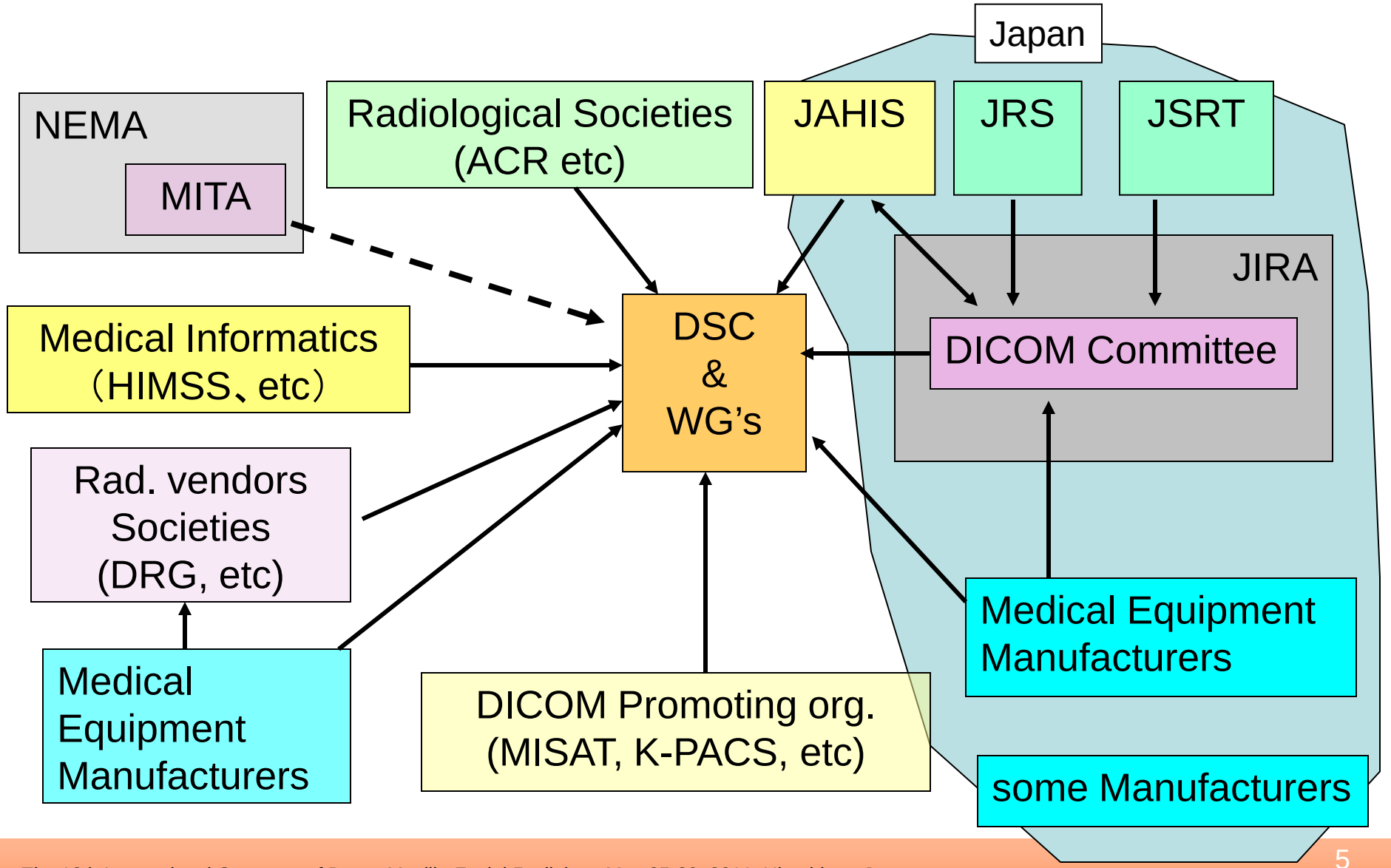
2) Application of DICOM to Dental
   vs. mammography

3) Other related Standards

DICOM Standard overview

- Digital Imaging and COmmunication in Medicine
- Medical equipment vendors and users world-wide contribute the progress of DICOM standard, and it is officially supported by NEMA,USA.
- Corrections and Supplements are accepted any time, and the latest version including them is issued every year as DICOM2008, DICOM2009,,,,,
- DICOM standard is written in English, and the Japanese translation is located at JIRA homepage.

DSC: DICOM Standard Committee



MITA : http://medical.nema.org/

DICOM is managed by the Medical Imaging & Technology Alliance – a division of NEMA

Search the DICOM website
Search

2010 International Conference and Seminar

PURPOSE & ORGANIZATION

- Strategic Document & Principal Contacts
- Members of the DICOM Standards Committee
- Approved Work Items
- DICOM Brochure
- NEMA/Medical

PROCESS

- DICOM Procedures
- Meeting Schedule
- Meeting Minutes
- Demonstrations, Presentations & Workshops
- Patent Disclosures
- Public FTP Site

PRODUCTS

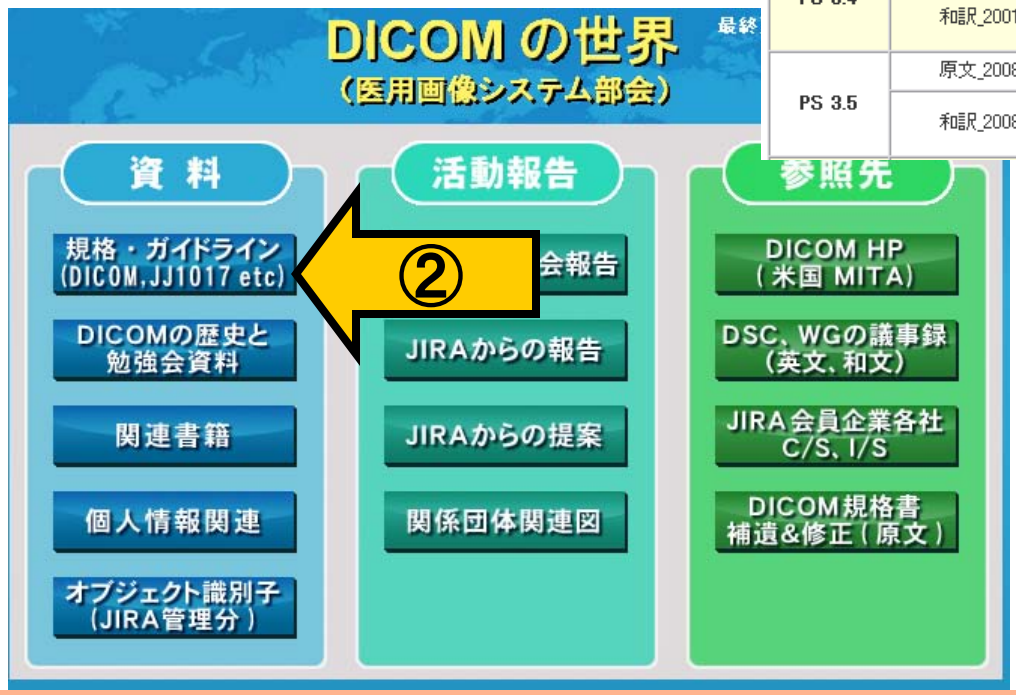
- The DICOM Standard
- Recently Approved Change Proposals
- Recently Approved Supplements
- Legal Issues (Trademark)

JIRA Home-page http://www.jira-net.or.jp/index.htm

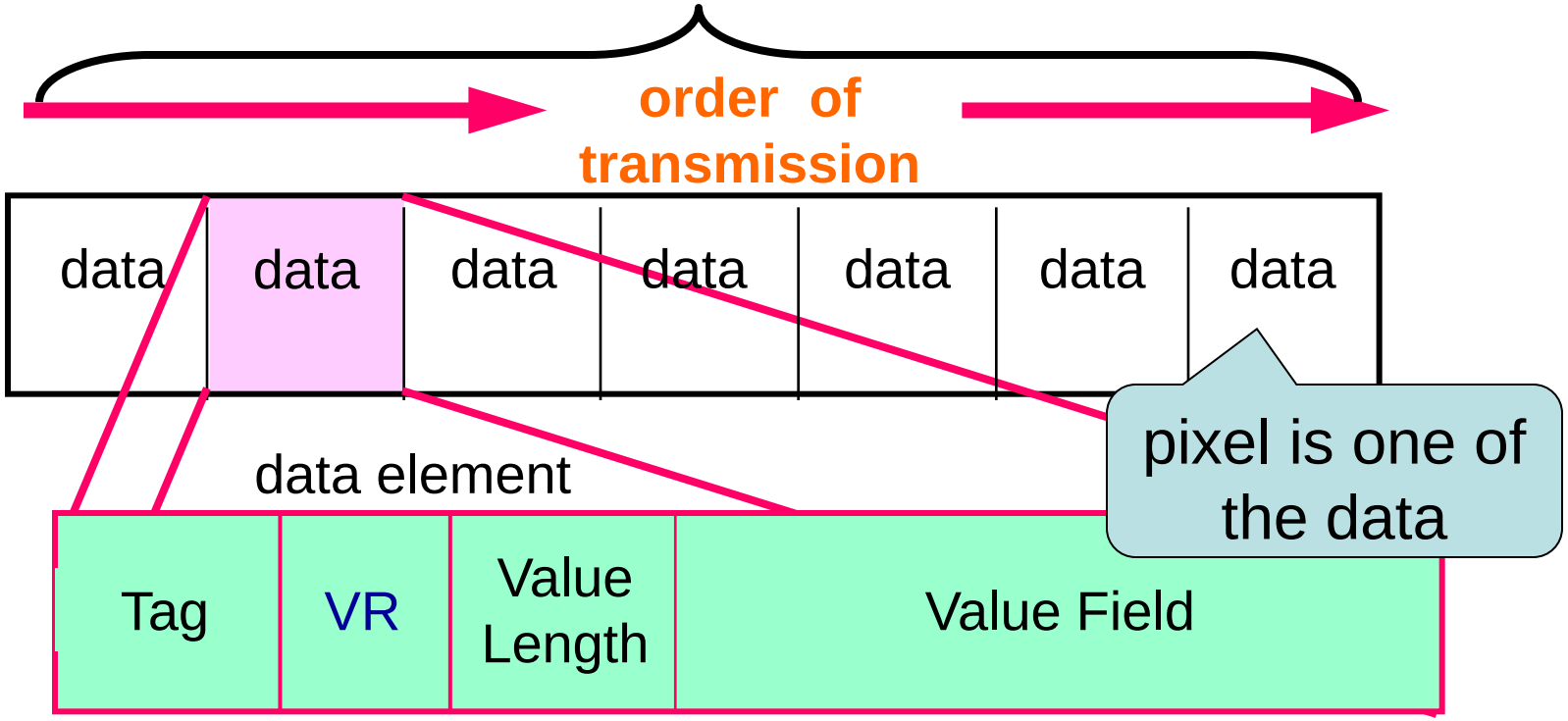
DICOM規格最新英語版/翻訳版

PS	原文/和訳	CONTENTS
PS 3.1	原文_2008	Part 1: Introduction and Overview
	和訳_2001	PS3.1－2001翻訳 医療における…ジタル画像と通信(DICOM) 巻1:序文と概要PS 3.1-
PS 3.2	原文_2008	Part 2: Conformance
	和訳_2001	PS3.2－2001翻訳 医療における…ジタル画像と通信(DICOM) 巻2:適合性
PS 3.3	原文_2008	Part 3: Information Object Definitions
	和訳_2001	PS3.3－2001翻訳 医療におけるデジタル画像と通信(DICOM) 巻3:情報オブジェクト定義
PS 3.4	原文_2008	Part 4: Service Class Specifications
	和訳_2001	PS3.4－2001翻訳 医療におけるデジタル画像と通信(DICOM) 巻4:サービスクラス仕様
PS 3.5	原文_2008	Part 5: Data Structures and Encoding
	和訳_2008	PS3.5-2008 翻訳 医療におけるデジタル画像と通信(DICOM) 第5部:データ構造と符号化

③



One DICOM object
(one image , one patient info.)



Patient name **(0010,0010)** **PN** **32** **Yamada^taro=山田^太郎**

DICOM Standard example (MR image tags)

IMAGE STORAGE from MR to PACS

(0000,0100)	Command Field	1 0x0001 C-STORE-RQ
(0008,0005)	Specific Character Set	“¥ISO 2022 IR 87 "
(0008,0008)	Image Type	"DERIVED¥PRIMARY¥OTHER "
(0008,0016)	SOP Class UID	"1.2.840.10008.5.1.4.1.1.4 "
(0008,0018)	SOP Instance UID	"1.2.840.113701.4.2.9673.0.14415.0.1 "
(0008,0020)	Study Date	"20110527"
(0008,0030)	Study Time	"123000"
(0008,0050)	Accession Number	"201105270203451"
(0008,0060)	Modality	"MR"
(0010,0010)	Patient‘s Name	“緊急S222"
(0010,0020)	Patient ID	"1048010120"
(0018,0087)	Magnetic Field Strength	"0.35"
(7FE0,0010)	Pixel Data	524288Bytes

IMAGE STORAGE response from PACS

(0000,0100)	Command Field	32769 0x8001 C-STORE-RSP
(0000,0900)	Status	"0 0x0000"

DICOM Standard example (exam query tags)

MWM-SCU requests scheduled exam information

(0010,0010)	Patient's Name	0	""
(0010,0020)	Patient ID	0	""
(0010,0030)	Patient's Birth Date	0	""
(0010,0040)	Patient's Sex	0	""
(0040,0002)	Start Date	18	"20110527-20110527"
(0040,0003)	Start Time	12	"000000-235959 "

MWM-SCP returns patient information

(0010,0010)	Patient‘s Name	18	" testdata^inpatient"
(0010,0020)	Patient ID	10	"0000010508"
(0010,0030)	Patient's Birth Date	8	"19750520"
(0010,0040)	Patient's Sex	2	"M "
(0040,0002)	Start Date	8	"20110527"
(0040,0003)	Start Time	6	“094500"

- PS 3.3 defines information objects.
  - DICOM defines all activities with combination of Service and Object Pairs (SOP)
  - Defined objects are found in PS3.3 contents page.

- PS3.4 defines Services.
  - DICOM defines all activities with combination of Service and Object (SOP)
  - Defined services are found in PS3.4 contents page.
  - Service is activated by Service Class User (SCU), and responded by Service Class Provider (SCP).
  - each SOP is numbered for easy acknowledgement. (SOP Class UID)
    - MR Image Storage : 1.2.840.10008.5.1.4.1.1.1.2
    - IO Image Storage : 1.2.840.10008.5.1.4.1.1.1.3
  - each object is numbered with unique ID (SOP Instance UID)

- Each system needs to declare which DICOM SOP classes are supported in it.

Table 4.2-1 SOP CLASSES FOR STORAGE-SCU AE

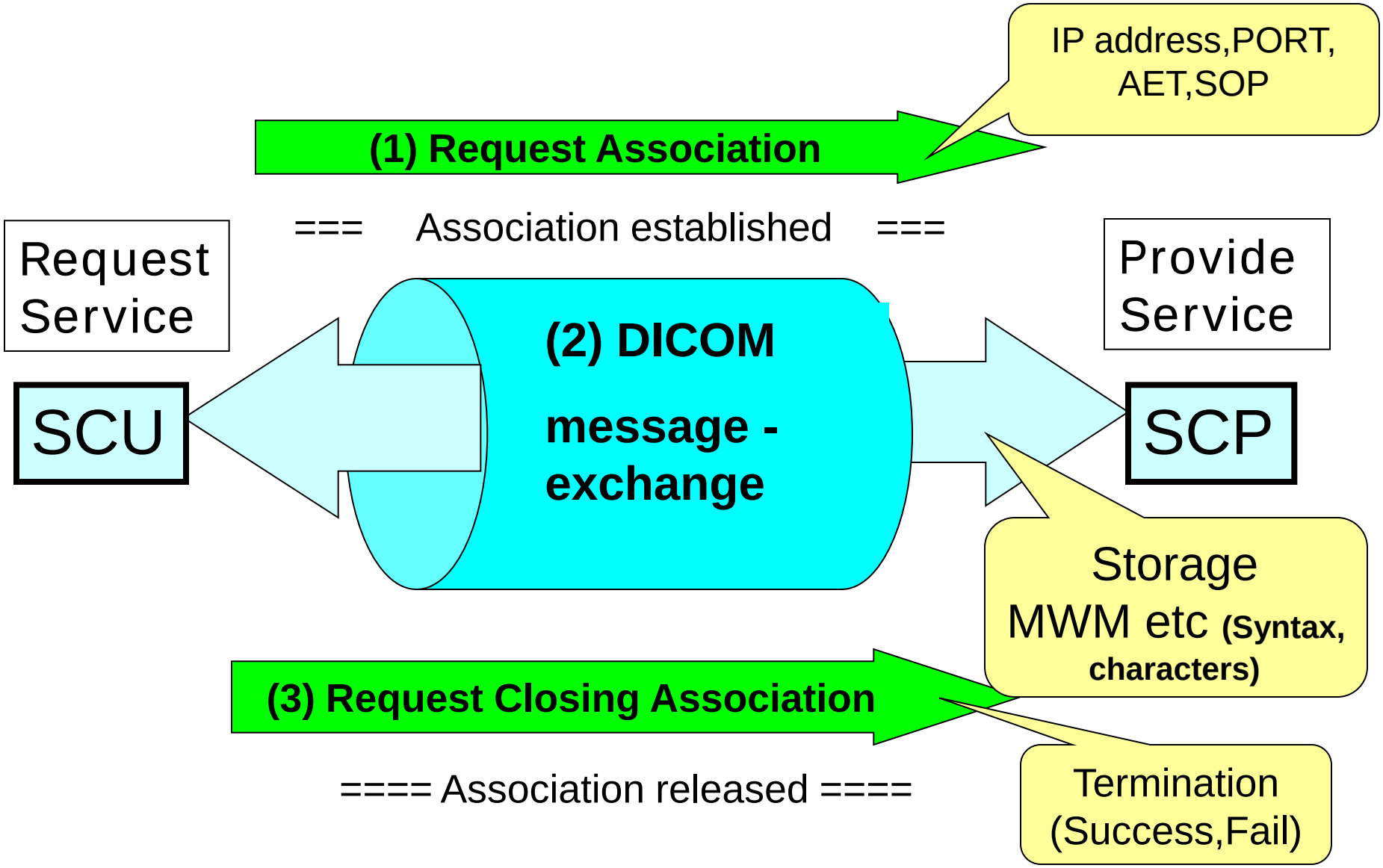
SOP Class Name	SOP Class UID	SCU	SCP
Verification	1.2.840.10008.1.1		
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1		
Digital X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.1		
Digital X-Ray Image Storage – For Processing	1.2.840.10008.5.1.4.1.1.1.1.1		
Digital Mammography X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.2		
Digital Mammography X-Ray Image	1.2.840.10008.5.1.4.1.1.1.2.1	Yes	No
Digital Intra-oral X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.3	Yes	No
Digital Intra-oral X-Ray Image Storage – For Processing	1.2.840.10008.5.1.4.1.1.1.3.1		No
CT Image Storage			
Enhanced CT Ima			

This document is called Conformance Statement. It is defined in PS3.2

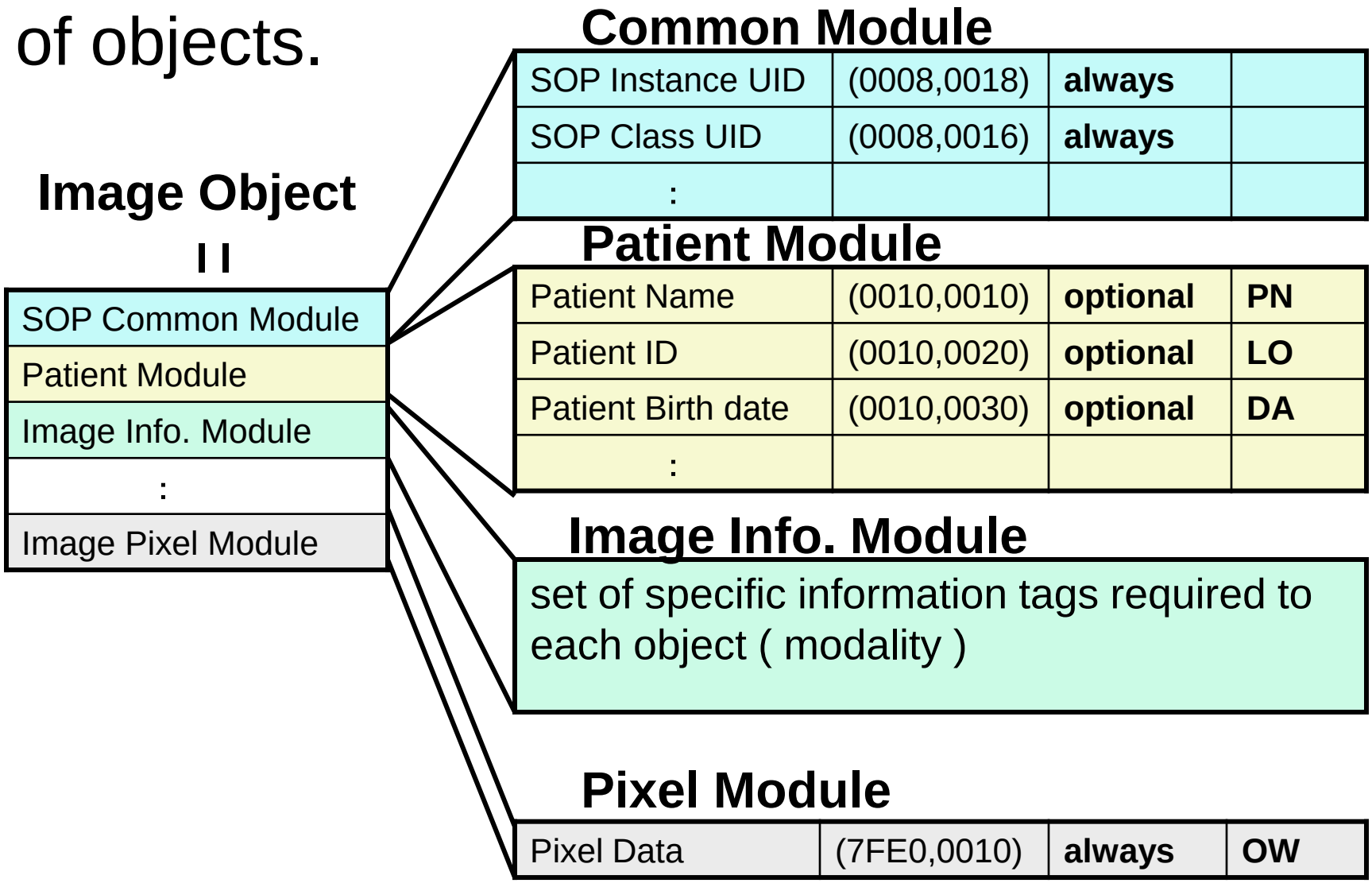
SCU

SOP Class Name	SOP Class UID
Verification SOP Class	1.2.840.10008.1.1
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1
Digital X-Ray Image Storage	1.2.840.10008.5.1.4.1.1.1.1
Digital Mammography X-Ray Image Storage	1.2.840.10008.5.1.4.1.1.1.2
Digital X-Ray Intra-oral X-Ray Image Storage	1.2.840.10008.5.1.4.1.1.1.3
CT Image Storage	1.2.840.10008.5.1.4.1.1.2

SCP


IP address,PORT, AET,SOP
(1) Request Association
=== Association established ===
Request Service
Provide Service
SCU
(2) DICOM message - exchange
SCP
Storage MWM etc (Syntax, characters)
(3) Request Closing Association
==== Association released ====
Termination (Success,Fail)

- PS3.5 defines the structure and representation of objects.



- Mammography and Oral images are defined as Objects in DICOM

	Mammo images	Dental images
# of objects	2 (R/L)	32 max.(4 quadrants)
# of images	2 or 4	3 to 14
imaging method	standardized	local standard
display method	standardized	local standard
object	MG (CR)	IO (CR)

Info. module of MG images (Mammography)

	image#1	#2	#3	#4
name	tag	value			
image type	(0008,0008)	MG	MG	MG	MG
image laterality	(0020,0062)	RIGHT	LEFT	RIGHT	LEFT
view code	(0054,0220)	yes	yes	yes	yes
>code value	(0008,0100)	R-10226	R-10226	R-10242	R-10242
>code designator	(0008,0102)	SNM3	SNM3	SNM3	SNM3
>code meaning	(0008,0104)	MLO	MLO	CC	CC

"SNM" defines how images should be taken.
It also defines how these images should be aligned on the monitor screen.

SNM ?

SNOMED Ver3

(Systematized Nomenclature of Medicine)

IHTSDO (International Health Terminology Standards Development Organization) maintains medical terminology with HWO.

http://www.ihtsdo.org/

Typical Imaging Technique: MLO & CC

Typical Display format: MLO(R/L) + CC(R/L)

Standardized by : SNM

MLO:

medio-lateral oblique

内外斜位方向

CC:

cephalad cranial

頭尾方向

MLO RIGHT MLO LEFT CC RIGHT CC LEFT

- The method of taking and displaying mammography images is standardized.
  - same # of images per exam.
  - same imaging method (exposure angle)
  - same display format.
  - they are controlled / maintained by proper society and international standardization organization.

- DICOM can refer these external standards and make use of standardized imaging method and display format.

- DICOM data structure
  - Image information module
    - CR : No tags to specify how to take and display images
      (CR is used in various exams, there is no standard)
    - MG : SNM defines how to take and display images
      And there are tags to specify these.
      (pretty much standardized exam)
    - IO : There are tags to specify these….
      but none defines how to take and display images.

Typical CR image Information tags

attribute	TAG	example
Photometric Interpretation	(0028,0004)	MONOCHROME2
kV	(0018,0060)	150
mA	(0018,1151)	80
Cassette Size	(0018,1403)	35CMX43CM

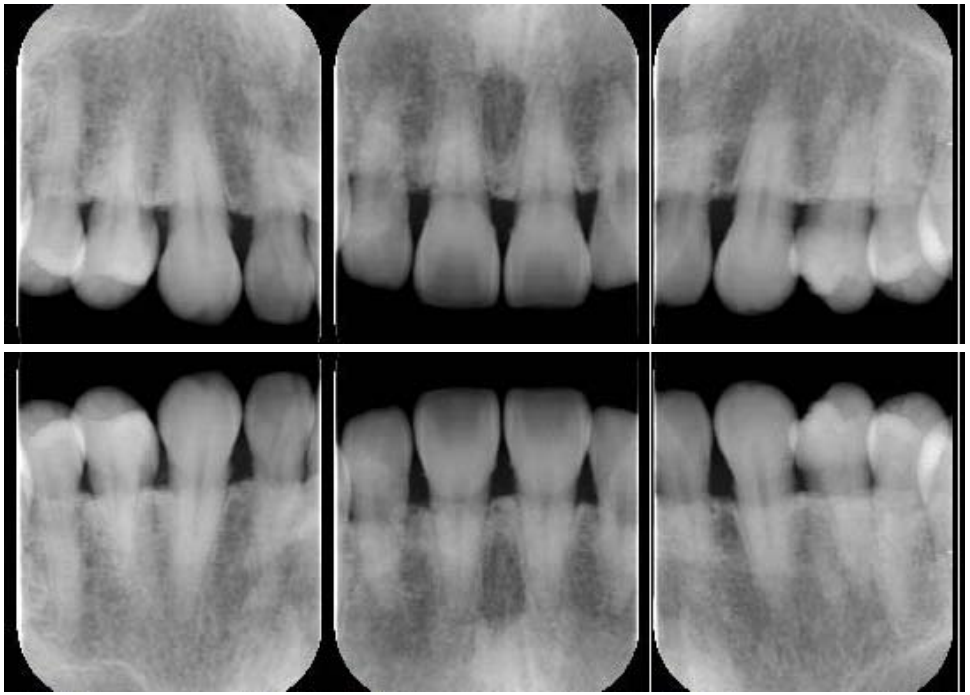
If a Intra-Oral image (IO) is taken by CR, these tags are added to the image.

name	tag	value
Positioner type	(0018,1508)	CEPHALOSTAT
image laterality	(0020,0062)	RIGHT
anatomic region sequence	(0008,2218)	11
code sequence macro		yes
>coding scheme designator	(0008,0102)	ISO 3950-1984
>primary anatomic structure seq.	(0008,2228)	11¥12¥13

- Image Info. module contains modality-specific information. By using it, post-processing or display format can be automatically defined IF THERE IS A STANDARD and DATA IS THERE.

So, What is defined as a standard in DICOM related to DENTAL ?

If dental images are taken as CR (not IO),
the position (anatomic region resolution) will be one of RIGHT / BOTH / LEFT.
BUT WE NEED MORE RESOLUTION ! teeth by teeth



If these images are taken as CR, there is no tag to tell upper or lower teeth.

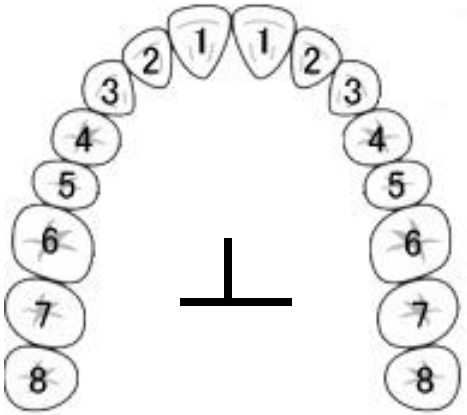
DICOM accepts teeth indexing method.

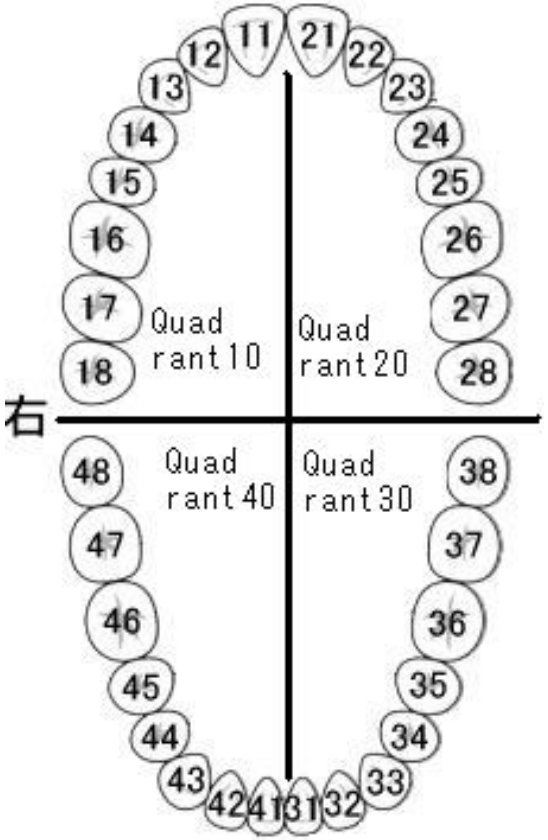
That is ISO 3950－1984.

Problem No1:

Each domain uses

local naming system.

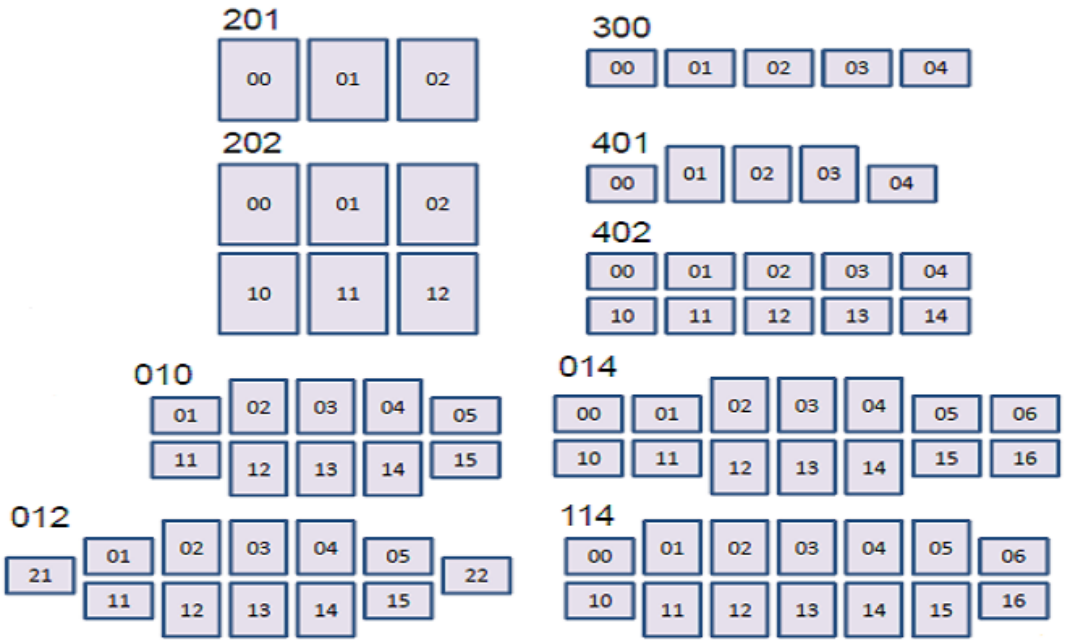




Problem No2:

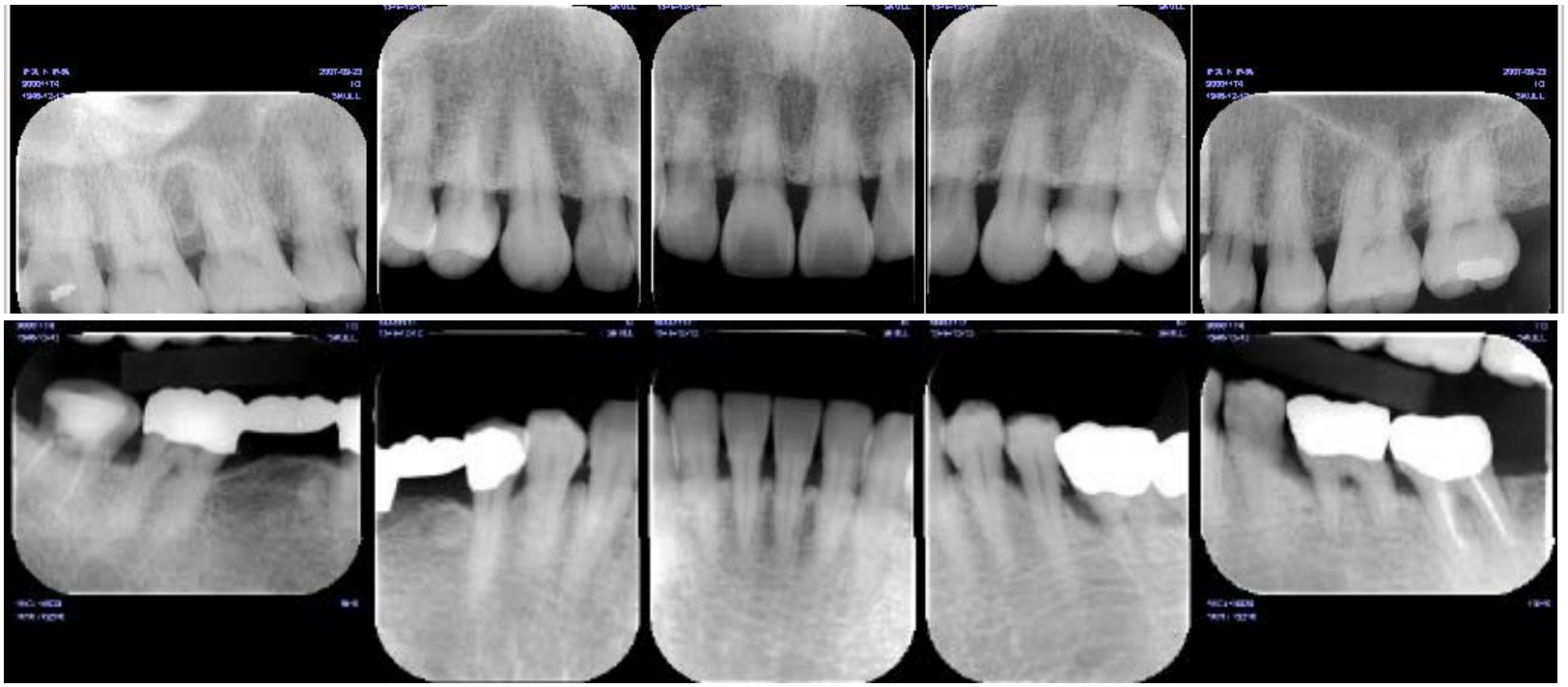
- Which image in the set covers which tooth is not standardized. (physical size , overlap, missing ones)

- Also its variety is not registered / maintained (internationally)



- what is IDEAL ?

  These 10 images must align to correct position AUTOMATICALLY. (By using some tag info.)



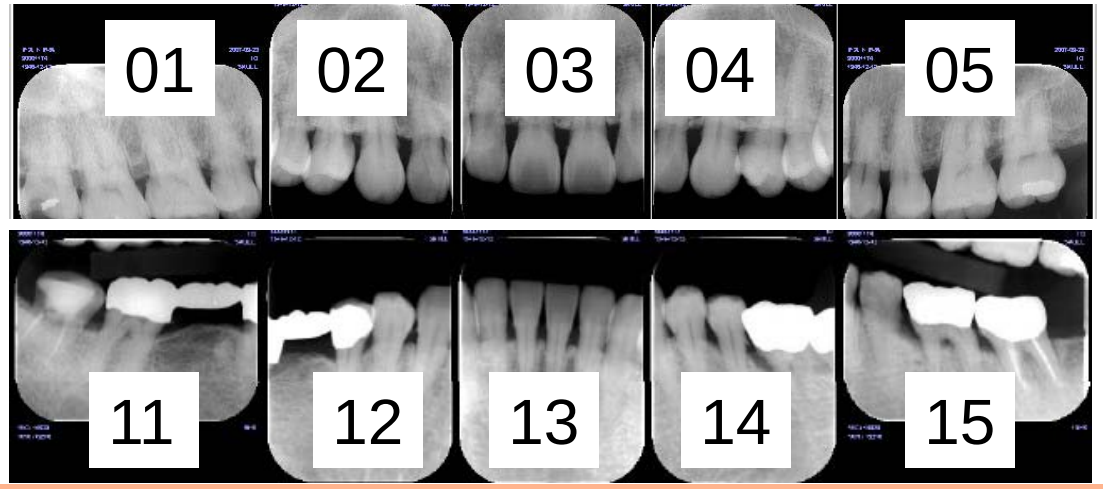
To automatically display these images in correct order, there must be some info. to tell…

(1) Which imaging method is used

10-image / 14-image / etc

(2) image index according to (1)

01-05/11-15 in 10-image method



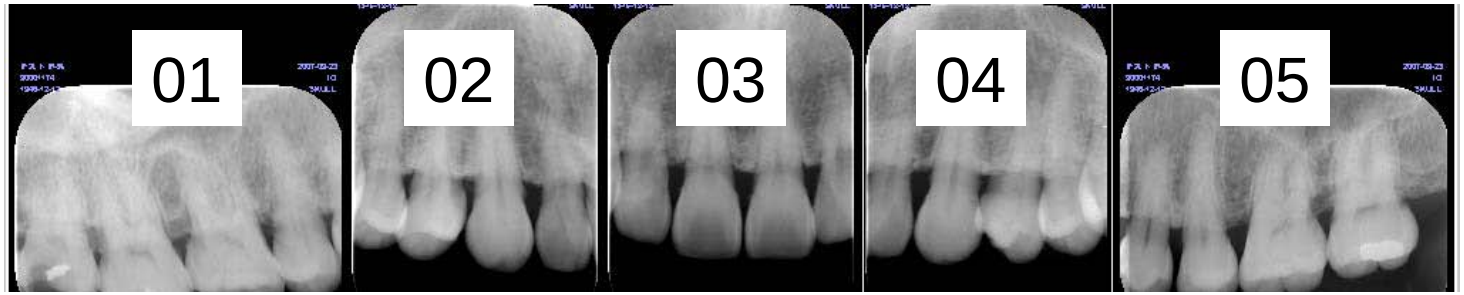
If we add some new tags to DICOM…

(0008,22XX) : Imaging method (10-image/14-image..)

(0008,22YY) : Image position index

(0008,2228) : Anatomic Structure Sequence

tag	data	data	data	data	data
(0008,0008)	IO	IO	IO	IO	IO
(0020,0062)	RIGHT	RIGHT	BOTH	LEFT	LEFT
(0008,2218)	yes	yes	yes	yes	yes
>(0008,22XX)	IMG10	IMG10	IMG10	IMG10	IMG10
>(0008,22YY)	01	02	03	04	05
>(0008,2228)	18¥17¥ 16¥15	15¥14¥ 13¥12	12¥11¥ 21¥22	22¥23¥ 24¥25	25¥26¥ 27¥28



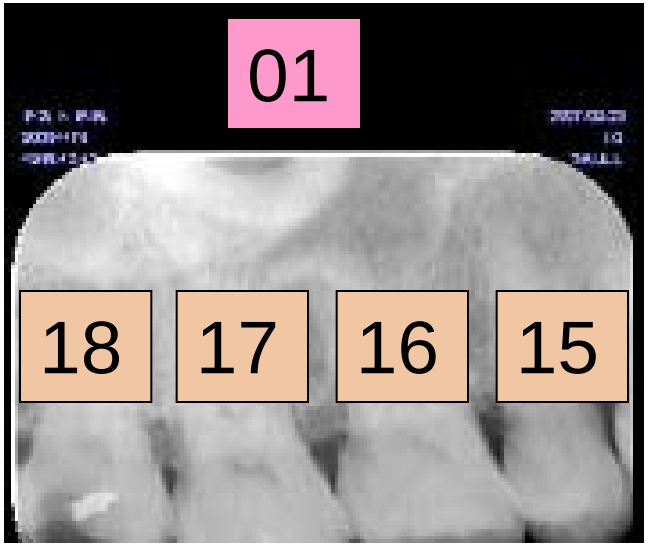
tag	data	data	data	data	data
(0008,0008)	IO	IO	IO	IO	IO
(0020,0062)	RIGHT	RIGHT	BOTH	LEFT	LEFT
(0008,2218)	yes	yes	yes	yes	yes
>(0008,22XX)	IMG10	IMG10	IMG10	IMG10	IMG10
>(0008,22YY)	01	02	03	04	05
>(0008,2228)	18¥17¥ 16¥15	15¥14¥ 13¥12	12¥11¥ 21¥22	22¥23¥ 24¥25	25¥26¥ 27¥28

And if teeth index are somehow entered in **(0008,2228)** Primary Anatomic Structure Sequence, you can find which image each teeth is imaged in.

This information can be used to find/retrieve images of specific teeth.

PROBLEM : How to detect and index each teeth in an image.

tag	data
(0008,0008)	IO
(0020,0062)	RIGHT
(0008,2218)	yes
>(0008,22XX)	IMG10
>(0008,22YY)	01
>(0008,2228)	18¥17¥16¥15



- We need to do these AUTOMATICALLY
  - set imaging method (10-image, 14-image,,)
  - set image index number (out of 10/14 images)
  - set tooth index number (out of 32 teeth)

  - and enable all related equipments to handle these information.

- Then all Intra-oral images will be displayed correctly on monitor. And the same tooth in previous exam can be found (retrieved).

Other related Standards IHE profile

(1) IHE : Integrating Healthcare Enterprise

- IHE is NPO from medical and manufacturers.
- IHE defines many profiles.

  (standardized relationship of related personnel (Actor) and information (Object))
- Profiles are created from practical routine work.

Some profiles can be applied to dental procedures.

- Scheduled Workflow (SWF)
- Consistent Presentation of Images (CPI)
- Portable Data for Imaging (PDI) and more

- Profiles defined by IHE are found at
  - IHE homepage http://www.ihe.net/
  - Japanese translation
    http://www.ihe-j.org/links/index.html

FIN

1) DICOM defines most of medical image format, and its communication method.
2) Dental images has wide variety of taking images, and showing them, mainly due to physical diversity. This makes it difficult to standardize the exam.
3) DICOM provides tags to arrange images on monitor, or specify each small structure.
4) DICOM can refer external standards to coordinate with them.

Thank You