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8	Correction Number CP-2540	
9	Log Summary: Clarify Concatenation Number of Frames	
10	Name of Standard	
11	PS3.3, PS3.6	
12	Rationale for Correction:	
13	There is no question that the use of Concatenations depends on the Number of Frames value being the number of Frames encoded	
14	in the actual SOP Instance that is the part of the Concatenation.	
15	Some may be confused that it is instead the total number of Frames in the Multi-frame Image that spans the Instances of the	
16	Concatenation re-combined.	
17	Resolve any potential confusion by adding a new optional Attribute to reflect the total number of Frames, add notes clarifying the	
18	difference, improve the definition of the Number of Frames Attribute throughout (even for uses in which Concatenations are not	
19	applicable, for consistency), factor out the description of a Multi-frame Image into the definition, factor out the description of a	
20	Concatenation into a new definition, and remove mention of specific Attributes in the Information Entity description.	
21	Also clarify extraneous mention of a contiguous stream of pixels, which is only applicable to an uncompressed encoding.	
22	Correction Wording:	

Amend DICOM PS3.3 as follows (changes to existing text are bold and underlined for additions and ~~struckthrough~~ for removals):

3 Definitions

For the purposes of this Standard the following definitions apply.

3.8 DICOM Information Object

<u>Concatenation</u>	<u>A Multi-frame Image that has been split into more than one SOP Instance.</u>
Frame	A single two-dimensional pixel plane of a Multi-frame Image.
Multi-frame Image	An image that contains whose pixel data consists of multiple two-dimensional pixel planes. <u>An uncompressed unencapsulated Multi-frame Image is transmitted as a single contiguous stream of pixels within the Instance in which it is encoded, though it may be split into Instances of a Concatenation (each of which is also a Multi-frame Image). Encapsulated Multi-frame Image pixel data may be delimited between frames depending on the Transfer Syntax.</u>

7.5 Organizing Large Sets of Information

For the purpose of accommodating large sets of frames in Multi-frame Image SOP Instances the Real-World Entity Relationship Diagram has been extended to describe the relationships of these instances: Concatenation (see Section 7.5.1) and Dimension Organization (see Section 7.5.2). Figure 7.5-1 depicts the additions to ???.

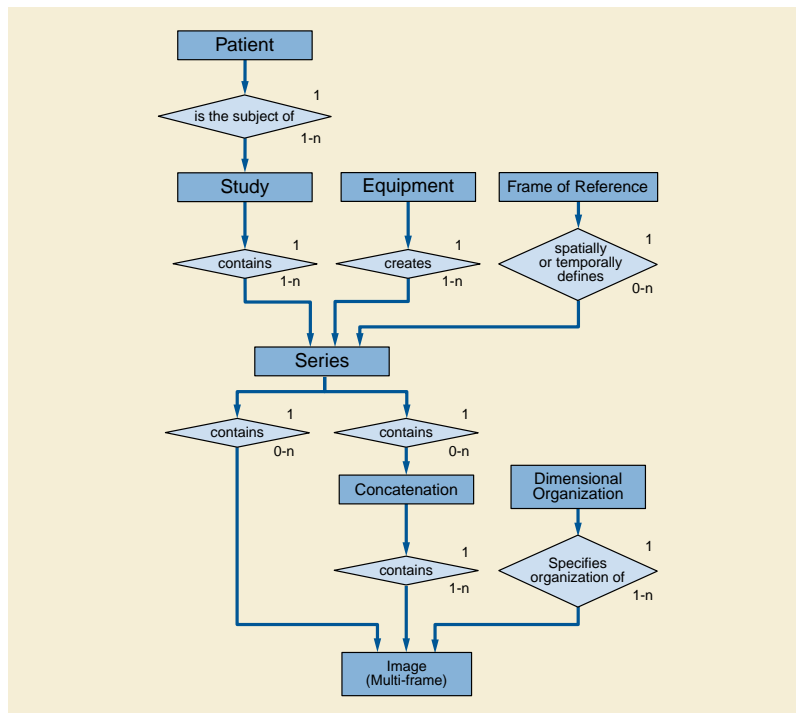


Figure 7.5-1. Extension of the Real World Model with Concatenations and Dimensions

7.5.1 Concatenation

For implementation specific reasons (such as practical limits on the maximum size of an individual SOP Instance) ~~the content of a~~ Multi-frame Image may need to be split into more than one SOP Instance. ~~These SOP Instances, each of which is also a Multi-frame Image, and all of which~~ together form a Concatenation, ~~which is a group of. The~~ SOP Instances ~~that comprise a Concatenation shall be~~ within a single Series ~~that is uniquely identified by Concatenation UID (0020,9164). Multiple different Concatenation~~

enations can be present in the same Series. Different source Multi-frame Images shall not be combined into a single Concatenation (i.e., the Concatenation source shall be a single Multi-frame Image).

7.5.2 Dimension Organization

C.7.6.6 Multi-frame Module

Table C.7-14 specifies the Attributes of the Multi-frame Module, which describe a Multi-frame ~~pixel data~~ Image.

Table C.7-14. Multi-frame Module Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Frames	(0028,0008)	1	Number of frames in athe Multi-frame Image <u>in this SOP Instance</u> . See Section C.7.6.6.1.1 for further explanation.
...			
Encapsulated Pixel Data Value Total Length	(7FE0,0003)	3	The length of the pixel data bit stream encapsulated in Pixel Data (7FE0,0010), in bytes, when all the fragments have been combined, not including any trailing padding to even length in the last Fragment added for encapsulation. Note This value will depend on the Transfer Syntax in which the Pixel Data (7FE0,0010) is encoded, and may need to be updated depending on the Transfer Syntax negotiated and selected for a particular transfer. See PS3.5 Section 8.2 "Native or Encapsulated Format Encoding".

C.7.6.6.1 Multi-frame Module Attribute Descriptions

C.7.6.6.1.1 Number of Frames

~~A Multi-frame Image is defined as a Image whose pixel data consists of a sequential set of individual Image Pixel frames. A Multi-frame Image is transmitted as a single contiguous stream of pixels. Frame headers do not exist within the data stream.~~

The total number of frames contained within a SOP Instance of a Multi-frame Image is conveyed in the Number of Frames (0028,0008). Number of Frames (0028,0008) shall have a value greater than zero.

C.7.6.16 Multi-frame Functional Groups Module

Table C.7.6.16-1. Multi-frame Functional Groups Module Attributes

Attribute Name	Tag	Type	Attribute Description
...			
Number of Frames	(0028,0008)	1	Number of frames in athe Multi-frame Image <u>in this SOP Instance</u> . See Section C.7.6.6.1.1 for further explanation.
...			

Attribute Name	Tag	Type	Attribute Description
Concatenation Frame Offset Number	(0020,9228)	1C	<p>Offset of the first frame in a Multi-frame Image of a Concatenation. Logical frame numbers in a Concatenation can be used across all its SOP Instances. This offset can be applied to the implicit frame number to find the logical frame number in a Concatenation. The offset is numbered from zero; i.e., the instance of a Concatenation that begins with the first frame of the Concatenation has a Concatenation Frame Offset Number (0020,9228) of zero.</p> <p>Required if Concatenation UID (0020,9161) is present.</p>
Representative Frame Number	(0028,6010)	3	The frame number selected for use as a pictorial representation (e.g., icon) of the Multi-frame Image.
Concatenation UID	(0020,9161)	1C	<p>Identifier of all SOP Instances that belong to the same Concatenation.</p> <p>Required if a group of Multi-frame Image SOP Instances within a Series are part of a Concatenation.</p>
SOP Instance UID of Concatenation Source	(0020,0242)	1C	<p>The SOP Instance UID of the single composite SOP Instance of which the Concatenation is a part. All SOP Instances of a Concatenation shall use the same value for this Attribute, see Section C.7.6.16.1.3.</p> <p>Note</p> <p>May be used to reference the entire Instance rather than individual Instances of the Concatenation, which may be transient (e.g., from a presentation state).</p> <p>Required if Concatenation UID (0020,9161) is present.</p>
In-concatenation Number	(0020,9162)	1C	<p>Identifier for one SOP Instance belonging to a Concatenation. See Section C.7.6.16.2.2.4 for further specification. The first Instance in a Concatenation (that with the lowest Concatenation Frame Offset Number (0020,9228) value) shall have an In-concatenation Number (0020,9162) value of 1, and subsequent Instances shall have values monotonically increasing by 1.</p> <p>Required if Concatenation UID (0020,9161) is present.</p>
In-concatenation Total Number	(0020,9163)	3	<p>The number of SOP Instances sharing the same Concatenation UID.</p> <p>If present, shall have a value greater than one, unless an IOD overrides this constraint to enumerate a value of 1 to prevent the use of Concatenations (e.g., ...).</p>
<u>Total Number of Frames in Concatenation</u>	<u>(0020,eee1)</u>	<u>3</u>	<p><u>Total number of frames in all SOP Instances that comprise the Concatenation that is a Multi-frame Image.</u></p> <p><u>If present, shall have a value greater than zero.</u></p>
Encapsulated Pixel Data Value Total Length	(7FE0,0003)	3	<p>The length of the pixel data bit stream encapsulated in Pixel Data (7FE0,0010), in bytes, when all the fragments have been combined, not including any trailing padding to even length in the last Fragment added for encapsulation.</p> <p>Note</p> <p>This value will depend on the Transfer Syntax in which the Pixel Data (7FE0,0010) is encoded, and may need to be updated depending on the Transfer Syntax negotiated and selected for a particular transfer. See PS3.5 Section 8.2 "Native or Encapsulated Format Encoding".</p>

C.7.6.16.1 Multi-frame Functional Groups Module Attribute Description

C.7.6.16.1.3 SOP Instance UID of Concatenation Source

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C.7.6.16.2 Common Functional Group Macros

C.7.6.16.2.2 Frame Content Macro

...

C.7.6.16.2.2.4 Concatenations and Stacks

~~Due to implementation specific reasons (such as maximum object size) the information of a Multi-frame Image may be split into more than one SOP Instance. These SOP Instances form together a Concatenation. This is a group of The SOP Instances within a Series that comprise a Concatenation shall be~~ uniquely identified by the same Value of Concatenation UID (0020,9161).

...

In a Concatenation the Dimension Index Sequence (0020,9222) Items of the Shared Functional Groups Sequence (5200,9229) shall be identical and have the same values for all individual SOP Instances. The Items of the Per-Frame Functional Groups Sequence (5200,9230) shall be identical for all individual SOP Instances but the values may change per frame. For all other Attributes of all the Modules of the IOD, the same Attributes shall be present and the values shall be identical, with the exception of the following Attributes:

- Number of Frames (0028,0008)
- Concatenation Frame Offset Number (0020,9228)
- In-concatenation Number (0020,9162)
- SOP Instance UID (0008,0018)
- Instance Creation Time (0008,0013)
- Extended Offset Table (7FE0,0001)
- Extended Offset Table Lengths (7FE0,0002)

Note

1. The intent of Concatenations is to split what might have been encoded in a single SOP Instance into smaller fragments for more convenient storage or transmission. All the multiple SOP Instances of a Concatenation should be able to be assembled into a valid single SOP Instance Hence it is not permitted to change such Attributes as Photometric Interpretation (0028,0004), Rows (0028,0010), Columns (0028,0011), etc.
2. Within each SOP Instance that comprises the Concatenation, the Number of Frames (0028,0008) Value is the number of frames within that SOP Instance, not the total number of frames in the Concatenation, which may be described in Total Number of Frames in Concatenation (0020,eee1).
3. When multiple SOP Instances of a Concatenation are combined into a single SOP Instance, the Basic Offset Table, if populated, and the Extended Offset Table (7FE0,0001) and Extended Offset Table Lengths (7FE0,0002), if present, need to be regenerated to match the new content of the Pixel Data attribute.

...

C.7.6.29 Sparse Multi-frame Functional Groups Module

...

Table C.7.6.29-1. Sparse Multi-frame Functional Groups Module Attributes

Attribute Name	Tag	Type	Attribute Description
...			
Number of Frames	(0028,0008)	1	Number of frames in the Multi-frame Image <u>in this SOP Instance</u> . See Section C.7.6.6.1.1 for further explanation.
...			
Concatenation Frame Offset Number	(0020,9228)	1C	Offset of the first frame in a Multi-frame Image of a Concatenation. Logical frame numbers in a Concatenation can be used across all its SOP Instances. This offset can be applied to the implicit frame number to find the logical frame number in a Concatenation. The offset is numbered from zero; i.e., the instance of a Concatenation that begins with the first frame of the Concatenation has a Concatenation Frame Offset Number (0020,9228) of zero. Required if Concatenation UID (0020,9161) is present.
Representative Frame Number	(0028,6010)	3	The frame number selected for use as a pictorial representation (e.g., icon) of the Multi-frame Image.
Concatenation UID	(0020,9161)	1C	Identifier of all SOP Instances that belong to the same Concatenation. Required if a group of Multi-frame Image SOP Instances within a Series are part of a Concatenation.
SOP Instance UID of Concatenation Source	(0020,0242)	1C	The SOP Instance UID of the single composite SOP Instance of which the Concatenation is a part. All SOP Instances of a Concatenation shall use the same value for this Attribute, see Section C.7.6.16.1.3. Note May be used to reference the entire Instance rather than individual Instances of the Concatenation, which may be transient (e.g., from a presentation state). Required if Concatenation UID (0020,9161) is present.
In-concatenation Number	(0020,9162)	1C	Identifier for one SOP Instance belonging to a Concatenation. See Section C.7.6.16.2.2.4 for further specification. The first Instance in a Concatenation (that with the lowest Concatenation Frame Offset Number (0020,9228) value) shall have an In-concatenation Number (0020,9162) value of 1, and subsequent Instances shall have values monotonically increasing by 1. Required if Concatenation UID (0020,9161) is present.
In-concatenation Total Number	(0020,9163)	3	The number of SOP Instances sharing the same Concatenation UID. If present, shall have a value greater than one, unless an IOD overrides this constraint to enumerate a value of 1 to prevent the use of Concatenations (e.g., ...).
<u>Total Number of Frames in Concatenation</u>	<u>(0020,eee1)</u>	<u>3</u>	<u>Total number of frames in all SOP Instances that comprise the Concatenation that is a Multi-frame Image.</u> <u>If present, shall have a value greater than zero.</u>

C.7.6.29.1 Sparse Multi-frame Functional Groups Module Attribute Descriptions**C.7.6.29.1.1 Selected Frame Functional Groups Sequence**

...

C.8.12.4 Whole Slide Microscopy Image Module

Table C.8.12.4-1. Whole Slide Microscopy Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
...			...
Number of Frames	(0028,0008)	1	Number of frames in athe Multi-frame Image <u>in this SOP Instance</u> . Enumerated Values if Image Type (0008,0008) Value 3 is THUMBNAIL, LABEL or OVERVIEW: 1 Note This Enumerated Value of 1 previously applied to Image Type (0008,0008) Value 3 of LOCALIZER, which has been retired. See PS3.3-2021c.
...			...

Amend DICOM PS3.6 as follows (changes to existing text are bold and underlined for additions and ~~struckthrough~~ for removals):

6 Registry of DICOM Data Elements

Table 6-1. Registry of DICOM Data Elements

Tag	Name	Keyword	VR	VM	
(0020,9228)	Concatenation Frame Offset Number	ConcatenationFrameOffsetNumber	UL	1	
<u>(0020,eee1)</u>	<u>Total Number of Frames in Concatenation</u>	<u>TotalNumberOfFramesInConcatenation</u>	<u>UL</u>	<u>1</u>	
(0028,0008)	Number of Frames	NumberOfFrames	IS	1	