DICOM Change Proposal

STATUS	Assigned
Date of Last Update	2025-04-13
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Change Number CP-2526
Log Summary: Harmonize capitalization of Data Element Types
Name of Standard PS3.2, PS3.3
Rationale for Change: It is proposed to harmonize the capitalization of the Data Element Types, i.e. consistently use “Type 1” instead of “type 1”, “Type 2” instead of “type 2”, and so on. It is also proposed that an (unnecessary) Note in PS3.3 be removed that refers to the definition of Type 1C and 2C in PS3.5, since this is the only reference of its kind in PS3.3 and there is no apparent reason why this should be useful at this point in particular. Furthermore, Type 2C does not appear at all in the preceding table.
Change Wording:

For reference, PS3.5 Section 7.4 (unchanged)

7.4 Data Element Type

An Attribute, encoded as a Data Element, may or may not be required in a Data Set, depending on that Attribute's Data Element Type.

The Data Element Type of an Attribute of an Information Object Definition or an Attribute of a SOP Class Definition is used to specify whether that Attribute is mandatory or optional. The Data Element Type also indicates if an Attribute is conditional (only mandatory under certain conditions). The Data Element Types of Attributes of Composite IODs are specified in PS3.3. The Data Element Types of Attributes of Normalized IODs are specified as Attributes of SOP Classes in PS3.4.

7.4.1 Type 1 Required Data Elements

IODs and SOP Classes define Type 1 Data Elements that shall be included and are mandatory Data Elements. The Value Field shall contain valid data as defined by the Data Element's VR and VM as specified in PS3.6. The Length of the Value Field shall not be zero. Absence of a valid Value in a Type 1 Data Element is a protocol violation.

Note

1. For Data Elements with a string (CS, SH, LO) rather than binary, text or sequence Value Representation, and for which multiple Values are allowed, the presence of a single Value is sufficient to satisfy the Type 1 requirement, unless specified otherwise in the Attribute description, and other Values may be empty, unless otherwise specified by the IOD. The presence of one or more delimiter (BACKSLASH) characters alone, without any Values, is not sufficient to satisfy the Type 1 requirement, since even though the Value Length is greater than zero, there is no valid Value present.

2. A Type 1 Sequence Data Element will contain one or more Items, as defined by the IOD (irrespective of the VM of the Sequence, which is always one (Section 7.5)). Whether or not those Items may be empty (contain no Data Elements) depends on the IOD definition of the Data Set for each Item.

7.4.2 Type 1C Conditional Data Elements

IODs and SOP Classes define Data Elements that shall be included under certain specified conditions. Type 1C Data Elements have the same requirements as Type 1 Data Elements under these conditions. It is a protocol violation if the specified conditions are met and the Data Element is not included.

When the specified conditions are not met, Type 1C Data Elements shall not be included in the Data Set unless it is specified that they may be present otherwise.

7.4.3 Type 2 Required Data Elements

IODs and SOP Classes define Type 2 Data Elements that shall be included and are mandatory Data Elements. However, it is permissible that if a Value for a Type 2 Data Element is unknown it can be encoded with zero Value Length and no Value. If the Value is known the Value Field shall contain that Value as defined by the Data Element's VR and VM as specified in PS3.6. These Data Elements shall be included in the Data Set and their absence is a protocol violation.

Note

1. The intent of Type 2 Data Elements is to allow a zero length to be conveyed when the operator or application does not know its Value or has a specific reason for not specifying its Value. It is the intent that the device should support these Data Elements.

2. A Type 2 Sequence Data Element will contain zero or more Items, as defined by the IOD (irrespective of the VM of the Sequence, which is always one (Section 7.5)). An empty Type 2 Sequence is one with no Items, as opposed to an Item that is present but empty. Whether or not Items may be empty (contain no Data Elements) depends on the IOD definition of the Data Set for each Item, rather than the Type of the enclosing Sequence Data Element.

7.4.4 Type 2C Conditional Data Elements

IODs and SOP Classes define Type 2C Data Elements that have the same requirements as Type 2 Data Elements under certain specified conditions. It is a protocol violation if the specified conditions are met and the Data Element is not included.

When the specified conditions are not met, Type 2C Data Elements shall not be included in the Data Set unless it is specified that they may be present otherwise.

Note

An example of a Type 2C Data Element is Inversion Time (0018,0082). For several SOP Class Definitions, this Data Element is required only if the Scanning Sequence (0018,0020) has the Value "IR." It is not required otherwise. See PS3.3.

7.4.5 Type 3 Optional Data Elements

IODs and SOP Classes define Type 3 Data Elements that are optional Data Elements. Absence of a Type 3 Data Element from a Data Set does not convey any significance and is not a protocol violation. Type 3 Data Elements may also be encoded with zero length and no Value. The meaning of a zero length Type 3 Data Element shall be precisely the same as that Data Element being absent from the Data Set.

7.4.6 Data Element Types Within A Sequence

When an IOD defines a Sequence Data Element (see Section 7.5), the Type of the Sequence Attribute defines whether the Sequence Attribute itself must be present, and the Attribute Description of the Sequence Attribute may define whether and how many Items shall be present in the Sequence. The Types of the Attributes of the Data Set included in the Sequence, including any conditionality, are specified within the scope of each Data Set, i.e., for each Item present in the Sequence.

Note

1. The Type and Attribute Description of the Sequence determines whether Items are present; conditionality constraints on Data Elements of the Items cannot force an Item to be present.

2. Historically, many IODs declared Type 1 and Type 2 Data Elements of the Sequence to be Type 1C and Type 2C, respectively, with the condition that an Item is present. This is exactly the same as simply defining them as Type 1 and Type 2.

3. In particular, the conditionality constraint "Required if Sequence is sent" on the Type 1C or Type 2C Data Elements subsidiary to a Type 2 or 3 Sequence Attribute does not imply that an Item must be present in the Sequence. These conditions are meant to be equivalent to "Required if a Sequence Item is present", and the conditionality is not strictly necessary. Any Type 2 or Type 3 Sequence Attribute may be sent with zero length.

4. In particular, the conditionality constraint "Required if <name-of-parent-sequence-attribute> is sent" on the Type 1C or Type 2C Data Elements subsidiary to a Type 2 or 3 Sequence Attribute does not imply that an Item must be present in the Sequence. These conditions are meant to be equivalent to "Required if a Sequence Item is present", and the conditionality is not strictly necessary. Any Type 2 or Type 3 Sequence Attribute may be sent with zero length.

Modify PS3.2 Section N.3.4 as indicated

(changes to existing text are bold and underlined for additions and bold and struckthrough for removals):

N.3.4 Terms and Definitions

[Terms and definitions should be listed here. The following list includes DICOM terms, delete terms that are not used throughout the Conformance Statement, but do not add or modify terms listed here.]

The following list includes DICOM Terms, that are used throughout this Conformance Statement:

[…]

Specialized SOP Class	A SOP Class that is derived from the Standard that is specialized by additional **~~t~~Type** 1, 1C, 2, 2C, or 3 Attributes, by enumeration of specific permitted Values for Attributes, or by enumeration of specific permitted Templates. The additional Attributes may either be drawn from the Data Dictionary in PS3.6 or may be Private Attributes.
Standard SOP Class	A SOP Class defined in the Standard, and that is implemented and used without any modifications.
Standard Extended SOP Class	A SOP Class that is defined in the standard, and that is extended by additional **~~t~~Type** 3 Attributes. The additional Attributes may either be drawn from the DICOM Data Dictionary in PS3.6 or may be Private Attributes.

[…]

Modify PS3.3 Section C.1.2.3 as indicated

(changes to existing text are bold and underlined for additions and bold and struckthrough for removals):

C.1.2.3 Type Designation

Each Attribute contained in a Module referenced by a Composite IOD defines a Type designation that indicates if a specific Attribute is required for all DIMSE operations/notifications associated with a SOP Class using this Module. PS3.5 defines a choice of generic Type designations available for DICOM Attributes.

Note

The Type designation specified is generally determined by the value most appropriate for the C-STORE DIMSE Service.

The Type designation given in a Module is a default value and as such may be overridden by an IOD referencing the Module. Some Attributes may also be contained in more than one Module for the IOD. In that case, the Type designation applicable for the Attribute of the specific IOD is the lowest Type value (e.g., if **~~t~~Type** 2 is specified in one Module and **~~t~~Type** 3 in another, then **~~t~~Type** 2 shall apply), unless explicitly stated by the Attribute description.

The Type designation given in a Module (and/or IOD) may also be overridden by Service Class Definitions referencing the IOD containing the Module. PS3.4 specifies the Service Class Definitions.

Modules referenced only by Normalized IODs do not contain Type designations. Modules referenced by both Normalized IODs and Composite IODs will contain a Type designation that only applies to Composite IODs and any specific conditions for Conditional Types (~~t~~**T**ype 1C and 2C) also only apply to Composite IODs.

Modify PS3.3 Section C.8.4.8 as indicated

(changes to existing text are bold and underlined for additions and bold and struckthrough for removals):

C.8.4.8 NM Multi-frame Module

Table C.8-7 specifies the Attributes of the NM Multi-frame Image. This Module is always included in a NM SOP Instance, even if there is only one frame in the image.

A NM Image object is always a multi-dimensional Multi-frame Image. The order and organization of the frames within each image is defined by the Frame Increment Pointer (0028,0009). The Frame Increment Pointer (0028,0009) references one or more indexing vectors. An indexing vector is a 1 dimensional array with exactly one element for each frame in the image. The value of the nth element in the indexing vector represents the index for the nth frame, in that dimension. Indices are always numbered starting from 1.

Note

The scheme for encoding a multi-dimensional array of frames into a single image object is as follows. First, the definition of the Data Element called the Frame Increment Pointer is changed so that it can be multi-valued (i.e., its VM is now 1-n). Each value of Frame Increment Pointer represents one of the dimensions of the array, with the last value representing the most rapidly changing index. Each value of Frame Increment Pointer is the Tag of a Data Element that is an indexing vector. An indexing vector is a 1 dimensional array with exactly one element for each frame in the image. The value of the n^{th} element in the indexing vector represents the index for the n^{th} frame, in that dimension. For example, suppose you are encoding a Dynamic image consisting of 2 phases (containing 5 and 2 frames, respectively), from each of two detectors, using one isotope, which gives a total of 14 frames in the image. For a Dynamic image, the Frame Increment Pointer is defined as:Frame Increment Pointer = Energy Window Vector (0054,0010) \ Detector Vector (0054,0020) \ Phase Vector (0054,0030) \ Time Slice Vector (0054,0100). Pixel Data (7FE0,0010) would contain the frames in the following order:

Frame	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Energy Window #	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Detector #	1	1	1	1	1	1	1	2	2	2	2	2	2	2
Phase #	1	1	1	1	1	2	2	1	1	1	1	1	2	2
Time Slice #	1	2	3	4	5	1	2	1	2	3	4	5	1	2

and the four vectors would be defined as:

Energy Window Vector = 1,1,1,1,1,1,1,1,1,1,1,1,1,1

Detector Vector = 1,1,1,1,1,1,1,2,2,2,2,2,2,2

Phase Vector = 1,1,1,1,1,2,2,1,1,1,1,1,2,2

Time Slice Vector = 1,2,3,4,5,1,2,1,2,3,4,5,1,2

The receiver can tell the relationship of all the frames from these four vectors. For instance, looking at the 11^{th} value in these four vectors tells you that the 11^{th} frame in this multi-frame object is time slice 4 of phase 1 from detector 2 and isotope 1.

The Energy Window, Detector, Phase, Rotation, R-R Interval, and Time Slot Vectors have corresponding Sequence Attributes that contain exactly one Sequence Item for each of the index values in the vector. The Sequence Item contains a set of Attributes that are specific to that group of frames, but change from one group

to the next. In the above example there would be a detector Sequence Attribute, an isotope Sequence Attribute and a phase Sequence Attribute (for dynamics, no frame Sequence Attribute is needed). The detector and phase Sequence Attributes would contain two Sequence Items (because there were 2 detectors and 2 phases).

Table C.8-7. NM Multi-frame Module Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1	Contains the Data Element Tags of one or more frame index vectors. See Section C.8.4.8.1.1 for further specialization.
Energy Window Vector	(0054,0010)	1C	An array that contains the energy window number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Energy Window Vector (0054,0010). See Section C.8.4.8.1.2 for specialization.
Number of Energy Windows	(0054,0011)	1	Number of energy window groupings. See Section C.8.4.8.1.2 for specialization.
Detector Vector	(0054,0020)	1C	An array that contains the detector number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Detector Vector (0054,0020). See Section C.8.4.8.1.3 for specialization.
Number of Detectors	(0054,0021)	1	Number of detectors. See Section C.8.4.8.1.3 for specialization.
Phase Vector	(0054,0030)	1C	An array that contains the phase number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Phase Vector (0054,0030). See Section C.8.4.8.1.4 for specialization.
Number of Phases	(0054,0031)	1C	Number of phases. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Phase Vector (0054,0030). See Section C.8.4.8.1.4 for specialization.
Rotation Vector	(0054,0050)	1C	An array that contains the rotation number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Rotation Vector (0054,0050). See Section C.8.4.8.1.5 for specialization.
Number of Rotations	(0054,0051)	1C	Number of rotations. Required if Image Type (0008,0008), Value 3 is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO. See Section C.8.4.8.1.5 for specialization.
R-R Interval Vector	(0054,0060)	1C	An array that contains the R-R interval number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for R-R Interval Vector (0054,0060). See Section C.8.4.8.1.6 for specialization.
Number of R-R Intervals	(0054,0061)	1C	Number of R-R intervals. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for R-R Interval Vector (0054,0060). See Section C.8.4.8.1.6 for specialization.
Time Slot Vector	(0054,0070)	1C	An array that contains the time slot number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Time Slot Vector (0054,0070). See Section C.8.4.8.1.7 for specialization.
Number of Time Slots	(0054,0071)	1C	Number of time slots. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Time Slot Vector (0054,0070). See Section C.8.4.8.1.7 for specialization.
Slice Vector	(0054,0080)	1C	An array that contains the spatial slice number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Slice Vector (0054,0080). See Section C.8.4.8.1.8 for specialization.

Attribute Name	Tag	Type	Attribute Description
Number of Slices	(0054,0081)	1C	Number of slices. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Slice Vector (0054,0080). See Section C.8.4.8.1.8 for specialization.
Angular View Vector	(0054,0090)	1C	An array that contains the angular view number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Angular View Vector (0054,0090). See Section C.8.4.8.1.9 for specialization.
Time Slice Vector	(0054,0100)	1C	An array that contains the time slice number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Time Slice Vector (0054,0100). See Section C.8.4.8.1.10 for specialization.

~~**Note**~~

~~**Per the rules in PS3.5, if an Attribute of Type 1C or 2C is not required, it shall not be included.**~~

Modify PS3.3 Section C.11.12 as indicated

(changes to existing text are bold and underlined for additions and bold and struckthrough for removals):

C.11.12 Presentation State Shutter Module

Table C.11.12-1 specifies the Attributes of the Presentation State Shutter Module, which specialize Attributes in other Modules included in a Presentation State.

Table C.11.12-1. Presentation State Shutter Module Attributes

Attribute Name	Tag	Type	Attribute Description
Shutter Presentation Value	(0018,1622)	1C	A single grayscale unsigned value used to replace those parts of the image occluded by the shutter, when rendered on a monochrome display. The units are specified in P-Values. Required if the Display Shutter Module or Bitmap Display Shutter Module is present. Note The requirement in this Module is **~~t~~Type** 1C, which overrides the **~~t~~Type 3** in the Display Shutter Module.
Shutter Presentation Color CIELab Value	(0018,1624)	1C	A color triplet value used to replace those parts of the image occluded by the shutter, when rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. Required if the Display Shutter Module or Bitmap Display Shutter Module is present and the SOP Class is other than Grayscale Softcopy Presentation State Storage. Note The requirement in this Module is **~~t~~Type** 1C, which overrides the **~~t~~Type** 3 in the Display Shutter Module and Bitmap Display Shutter Module.

Modify PS3.3 Section C.11.13 as indicated

(changes to existing text are bold and underlined for additions and bold and struckthrough for removals):

C.11.13 Presentation State Mask Module

Table C.11.13-1 specifies the Attributes of the Presentation State Mask Module, which specialize the use of masks in a Presentation State.

Table C.11.13-1. Presentation State Mask Module Attributes

Attribute Name	Tag	Type	Attribute Description
Mask Subtraction Sequence	(0028,6100)	1C	Required if Mask Module is present. Only a single Item shall be included in this Sequence. Applicable Frame Range (0028,6102) shall not be included in the Sequence Item. See Section C.7.6.10 for a complete definition of the Attributes in the Items of this Sequence other than Mask Operation (0028,6101) and Applicable Frame Range (0028,6102). Note 1. This Sequence is replicated here in order to specify one Item, additional conditions on Mask Operation (0028,6101) and to forbid Applicable Frame Range (0028,6102). 2. The role of Applicable Frame Range (0028,6102) is replaced by Referenced Frame Number (0008,1160).
>Mask Operation	(0028,6101)	1	Type of mask operation to be performed Enumerated Values: **AVG_SUB** **TID** See Section C.7.6.10.1 for further explanation. Note The requirement in this Module is for Enumerated Values, which overrides the requirements of the Mask Module.
>Contrast Frame Averaging	(0028,6112)	1C	Specified the number of contrast frames to average together before performing the mask operation. Required if Mask Frame Numbers (0028,6110) specifies more than one frame (i.e., is multi-valued). Note The requirement in this Module is conditional and overrides the optional requirements of the Mask Module.
Recommended Viewing Mode	(0028,1090)	1C	Specifies the recommended viewing protocol(s). Enumerated Values: **SUB** for subtraction with mask images Required if Mask Subtraction Sequence (0028,6100) is present.

Attribute Name	Tag	Type	Attribute Description
			Note The requirements in this Module are ~~t~~Type 1C and a specified Enumerated Value, which override the requirements of the Mask Module.

Modify PS3.3 Section C.36.2.2.5.1.1 as indicated

(changes to existing text are bold and underlined for additions and bold and struckthrough for removals):

C.36.2.2.5.1.1 Requirements for Changing Values within RT Control Point Sequence Attributes

This Section specifies when individual Attributes shall be present in a Sequence.

The RT Control Point Sequence specifies a certain order of execution.

At each RT Control Point the value of various Attributes may be specified as an explicit value (which in the case of a ~~t~~Type 2C Attribute may be a null value) and if absent remain at the same value as specified previously. There are physical and mechanical implications of specifying a new value as opposed to staying at the same value, for example gear lash, floating point jitter, etc.

At the first Sequence Item in RT Control Point Sequences (i.e., with an RT Control Point Index (300A,0600) equal to 1) all Attributes affected by this Section shall be present if applicable conditions are met.

For Sequence Items other than the first Sequence Item, Attributes shall be present if applicable conditions are met and the value is different from the previously populated value for the same Attribute (in the case of a ~~t~~Type 2C Attribute, a null value is considered as a value). The previously populated value is the value from the Item where the Attribute was present with the greatest value of RT Control Point Index (300A,0600) less than the value of the RT Control Point Index (300A,0600) in the current Item.

This means that for an Item in which an Attribute is absent, the application stays at the value of the previously populated Item.

For Sequences inside a RT Control Point Sequence Item, the Sequence shall be present if any of the nested Attributes affected by this Section differ from the corresponding previously populated Item.

For multi-valued Attributes, such as Parallel RT Beam Delimiter Positions (300A,064A), all values shall be present if any value changes.