DICOM Correction Proposal

Status: June 2014 Voting Packet

Date of Last Update: 2014/04/19

Person Assigned: David Clunie (dclunie@dclunie.com)

Submitter Name: David Flade (david.flade@brainlab.com)
Sven Flossmann (sven.flossmann@brainlab.com)
Heinz Blendinger (heinz.blendinger@siemens.com)
Wim Corbijn (wim.corbijn.van.willenswaard@philips.com)

Submission Date: 2013/10/xx

Correction Number: CP-1365

Log Summary: Support of more than 16 bit in point index lists

Name of Standard:
PS 3.3 2011, PS 3.6 2011, Sup 132 (FT), CP 1198 (FT), CP 1200 (FT)

Rationale for Correction:
The following attributes are encoded as OW:
- Primitive Point Index List (0066,0029)
- Triangle Point Index List (0066,0023)
- Edge Point Index List (0066,0024)
- Vertex Point Index List (0066,0025).

This limits the number of usable points within the Surface Segmentation IOD to 65,536 within one surface. However, surfaces can contain more than 65,536 points in many use cases.

This correction proposal adds alternative index lists which extend the limitation to 32 bit per point, which is practical for all use cases.

The suggestion to split surfaces > 65,536 points into several “patches” was discussed. However, this would lead to other issues with the usage of some attributes like “(0066,000E) Finite Volume” and “(0066,0010) Manifold”. Furthermore, with the current implementation of the standard there is no possibility to retain the topology of the surfaces if working around with patches.

For backward compatibility, the already existing index lists should be used. If more than 65,536 points are used, a reduced surface structure shall be stored into the existing index lists.

Correction Wording:

Amend PS 3.3:

C.27.2 Points Macro

Table C.27-2 specifies the Attributes of the Points Macro.

Table C.27-2
POINTS MACRO ATTRIBUTES

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Of Surface Points</td>
<td>(0066,0015)</td>
<td>1</td>
<td>Specifies the number of points in the</td>
</tr>
</tbody>
</table>
C.27.2.1 Points Macro Attribute Descriptions

All Attributes within this module containing points or vectors are in x-y-z order. If multiple elements are encoded, the ordering is \( x_1, y_1, z_1, \ldots, x_n, y_n, z_n \).

The points are in the coordinate system identified by the Frame of Reference UID (0020,0052). To map these points into the coordinate system of another SOP Instance a Spatial Registration Instance can be used.

C.27.2.1.1 Point Coordinates Data

When referencing individual points the index of the first point shall be 1.

**Note:** For the Attributes (defined in C.27.4 Surface Mesh Primitives Macro) that index the coordinates, the OW VR imposes the limitation to 65535 coordinates.

C.27.3 Vectors Macro

Table C.27-3 specifies the attributes of the Vectors Macro.

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Vectors</td>
<td>(0066,001E)</td>
<td>1</td>
<td>The number of vectors in the Vector Coordinate Data (0066,0021). See C.27.3.1.</td>
</tr>
<tr>
<td>Vector Dimensionality</td>
<td>(0066,001F)</td>
<td>1</td>
<td>The dimensionality of the underlying vector field. See C.27.3.1.</td>
</tr>
<tr>
<td>Vector Accuracy</td>
<td>(0066,0020)</td>
<td>3</td>
<td>A single standard deviation for all the vectors’ coordinates. The units shall be the same as the units of the coordinate system in which the vector coordinates are specified. See C.27.3.1.</td>
</tr>
<tr>
<td>Vector Coordinate Data</td>
<td>(0066,0021)</td>
<td>1</td>
<td>A data stream of coordinates encoded as floats. See C.27.3.1.</td>
</tr>
</tbody>
</table>

C.27.3.1 Vectors Macro Attribute Descriptions

All Attributes within this module containing points or vectors are encoded as multi-valued floats in an x-y-z ordering. If multiple elements are encoded, the ordering is \( x_1, y_1, z_1, \ldots, x_n, y_n, z_n \).

The vectors encoded in this macro can be anything from 1D to nD objects. The vectors are encoded as a stream of values in the Vector Coordinate Data (0066,0021) Attribute. Vector Dimensionality (0066,001F) defines how many subsequent entries in Vector Coordinate Data (0066,0021) describe one element. Vector Coordinate Data (0066,0021) shall have (Number of Vectors) x (Vector Dimensionality) values.

For measured vectors, the Vector Accuracy Attribute (0066,0020) describes the error per dimension in a multi-valued float attribute.
Notes: 1. The vectors are located at the points specified by the table including this macro.

2. Though not explicitly limited, so that the macro may be of general use, the Number of Vectors (0066,001E) is implicitly limited by the number of points specified by the table including this macro, which in the case of C.27.1 Surface Mesh Module, is the Number of Surface Points (0066,0015), which is limited to 65535, because of the limit on the number of index values.

C.27.4 Surface Mesh Primitives Macro

Table C.27-4 specifies the attributes of the Surface Mesh Primitives Macro.

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertex Point Index List</td>
<td>(0066,0025)</td>
<td>2</td>
<td>Contains n point indices describing Vertices. See C.27.4.1.</td>
</tr>
<tr>
<td><strong>Long Vertex Point Index List</strong></td>
<td>(0066,00xx)</td>
<td>2C</td>
<td>Contains n point indices describing Vertices. See C.27.4.1. Must be present if number of points in corresponding Surface Points Sequence (0066,0011) exceeds 65.536.</td>
</tr>
<tr>
<td>Edge Point Index List</td>
<td>(0066,0024)</td>
<td>2</td>
<td>Contains 2n point indices describing unconnected Edges. See C.27.4.1.</td>
</tr>
<tr>
<td><strong>Long Edge Point Index List</strong></td>
<td>(0066,00xx)</td>
<td>2C</td>
<td>Contains 2n point indices describing unconnected Edges. See C.27.4.1.</td>
</tr>
<tr>
<td>Triangle Point Index List</td>
<td>(0066,0023)</td>
<td>2</td>
<td>Contains 3n point indices describing unconnected Triangles. See C.27.4.1.</td>
</tr>
<tr>
<td><strong>Long Triangle Point Index List</strong></td>
<td>(0066,00xx)</td>
<td>2C</td>
<td>Contains 3n point indices describing unconnected Triangles. See C.27.4.1.</td>
</tr>
<tr>
<td>Triangle Strip Sequence</td>
<td>(0066,0026)</td>
<td>2</td>
<td>All Triangle Strips in this Surface. Zero or more items shall be included in this sequence.</td>
</tr>
<tr>
<td>&gt;Primitive Point Index List</td>
<td>(0066,0029)</td>
<td>1</td>
<td>See C.27.4.1.</td>
</tr>
<tr>
<td>&gt;<strong>Long Primitive Point Index List</strong></td>
<td>(0066,00xx)</td>
<td>1C</td>
<td>See C.27.4.1. Must be present if number of points in corresponding Surface Points Sequence (0066,0011) exceeds 65.536.</td>
</tr>
<tr>
<td>Triangle Fan Sequence</td>
<td>(0066,0027)</td>
<td>2</td>
<td>All Triangle Fans in this Surface. Zero or more items shall be included in this sequence.</td>
</tr>
<tr>
<td>&gt;Primitive Point Index List</td>
<td>(0066,0029)</td>
<td>1</td>
<td>See C.27.4.1.</td>
</tr>
</tbody>
</table>
### C.27.4.1  Surface Mesh Primitives Macro Attribute Descriptions

The Surface Mesh Primitives Macro uses point indices to reference the point rather than repeating point coordinates. All of the point coordinates used are specified within the Surface Points Sequence (0066,0011) of the same Surface Sequence (0066,0002) item. Point indices are described in C.27.2.1.1.

If more than 65,536 points shall be used per surface, the attributes starting with “Long” shall be used. To preserve backward compatibility, the attributes not starting with “Long” shall contain a reduced version of the described surface with indexes not exceeding the value of 65.536. This may affect the ordering of points in the Surface Points Sequence (0066,0011).

A Surface Mesh shall contain one or more of the following primitive types:

- **Vertex**
  - a single Vertex, referencing a single point

- **Edge**
  - an Edge, referencing two points

- **Line**
  - a series of connected points describing a path

- **Triangle**
  - a Triangle, referencing three points:

- **Triangle Strip**
  - a Triangle Strip with n triangles, referencing n+2 points. The first three referenced points describe the first triangle, the second, third and fourth referenced points describe the second triangle.

- **Triangle Fan**
  - a Triangle Fan with n triangles, referencing n+2 points. The first referenced point is in the center of the fan. Together with two subsequent referenced points, it describes a complete triangle.

- **Facet**
  - a closed planar polygon, referencing n points. The final point in the point index list shall be connected to the first point in the point index list to close the facet.
If the Surface Points Normals Sequence (0066,0012) is not present, the default normals can be derived from the Surface Mesh Primitives.

For the Triangle Strip, Triangle Fan, and Facet the Primitive Point Index List (0066,0029) the ordering of the point references implies the direction of the primitive’s normal: The normal points in the direction from which the referenced points are specified in a counterclockwise order. For finite volumes this shall be the outward direction.

For the Line primitive, the ordering of the point references defines a directed path, starting with the first point and ending with the last point referenced in each Primitive Point Index List (0066,0029).

For Primitives of type Triangle Strip or Triangle Fan, the orientation of the normals is given by the order of the points in the first triangle.

Note: These points may be used to compute normals to the primitive. (See section C.27.1.1.6.) The order these point references are presented in the Primitive Point Index List (0066,0029) will affect the direction the computed normal points. If the order of the point references is reversed, the direction of the normals will be reversed as well.

### Add new attributes to data dictionary PS 3.6

<table>
<thead>
<tr>
<th>Tag</th>
<th>Name</th>
<th>Keyword</th>
<th>VR</th>
<th>VM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0066,00xx)</td>
<td>Long Primitive Point Index List</td>
<td>LongPrimitivePointIndexList</td>
<td>UL</td>
<td>1-n</td>
</tr>
<tr>
<td>(0066,00xx)</td>
<td>Long Triangle Point Index List</td>
<td>LongTrianglePointIndexList</td>
<td>UL</td>
<td>3-3n</td>
</tr>
<tr>
<td>(0066,00xx)</td>
<td>Long Edge Point Index List</td>
<td>LongEdgePointIndexList</td>
<td>UL</td>
<td>2-2n</td>
</tr>
<tr>
<td>(0066,00xx)</td>
<td>Long Vertex Point Index List</td>
<td>LongVertexPointIndexList</td>
<td>UL</td>
<td>1-n</td>
</tr>
</tbody>
</table>