
**Information technology — Coding of
audio-visual objects —**

Part 16:

Animation Framework eXtension (AFX)

**AMENDMENT 3: Printing material and
3D graphics coding for browsers**

*Technologies de l'information — Codage des objets audiovisuels —
Partie 16: Extension du cadre d'animation (AFX)*

*AMENDEMENT 3: Représentation efficiente de maillages 3D à
multiples attributs*

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Amendment 3 to ISO/IEC 14496-16:2011 was prepared by ISO/IEC JTC 1, *Information technology, Subcommittee SC 29, Coding of audio, picture, multimedia and hypermedia information*.

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Information technology — Coding of audio-visual objects —

Part 16: Animation Framework eXtension (AFX)

AMENDMENT 3: Printing material and 3D graphics coding for browsers

Page 48, 4.3.6.4.2

Replace the following:

```
IndexedRegionSet {
  coord Coordinate {point [
    0 0 0, 1 0 0, 1 1 0, 0 1 0, 0 1 1, 0 0 1, 1 0 1, 1 1 1, 0.5 0.5 0
  ]}
  texCoord TextureCoordinate {point [
    0 0, 0.333 0, 0.667 0, 1 0, 0 1, 0.333 1, 0.667 1, 1 1, 0.667 0.5
  ]}
  region [
    Region {
      coordIndex [
        2 1 8 -1, 1 0 8 -1, 0 3 8 -1, 3 2 8 -1, 1 2 7 -1, 7 6 1 -1, 5 6 7 -1, 7 4 5 -1
      ]
      texCoordIndex [5 1 0 4 7 6 2 3 8]
      texture ImageTexture {url "../pix/136.png"}
    }
    Region {
      coordIndex [4 3 0 -1, 0 5 4 -1, 6 5 0 -1, 0 1 6 -1, 3 4 7 -1, 7 2 3 -1]
      texCoordIndex [4 7 6 5 1 0 3 2]
      texture ImageTexture {url "../pix/245.png"}
    }
  ]
}
```

With the following:

```
IndexedRegionSet {
[...]
  Region {
    coordIndex [
      2 1 8 -1, 1 0 8 -1, 0 3 8 -1, 3 2 8 -1, 6 5 0 -1, 0 1 6 -1, 5 6 7 -1, 7 4 5 -1
    ]
  }
[...]
```

```
  Region {
    coordIndex [4 3 0 -1, 0 5 4 -1, 1 2 7 -1, 7 6 1 -1, 3 4 7 -1, 7 2 3 -1]
  }
[...]
```

Replace the current 4.3.7 (which shall be renumbered to 4.3.8) with the following.

4.3.7 3D meshes with Printing Material Texture

4.3.7.1 General

The **IndexedPrintingRegionSet (IPRS)** node is based on the **IndexedRegionSet** described in 4.3.6 and it describes region-based printing material information which can be used in the 3D printing application. The main design concept of **IPRS** is that the representation shall be easy to the designer. Based on this concept, **IPRS** has adopted texture mapping method for describing the printing material information because it is very popular to the designer. Thanks to the region-based texture mapping, per face or region or global material mapping is possible.

4.3.7.2 IndexedPrintingRegionSet node

4.3.7.2.1 Node interface

IndexedPrintingRegionSet {

eventIn	MFInt32	set_colorIndex	
eventIn	MFInt32	set_coordIndex	
eventIn	MFInt32	set_normalIndex	
eventIn	MFInt32	set_texCoordIndex	
exposedField	SFString	unit	#mm, cm, m, inch
exposedField	SFFloat	minimumVerticalResolution	#unit is unit
exposedField	SFNode	color	NULL
exposedField	SFNode	coord	NULL
exposedField	SFNode	normal	NULL
exposedField	SFNode	texCoord	TRUE
field	SFBool	ccw	[] #[-1,inf)
field	MFInt32	colorIndex	TRUE
field	SFBool	colorPerVertex	TRUE
field	SFBool	convex	[]
field	MFNode	printingRegions	0 #[0,inf)
field	SFFloat	creaseAngle	[] #[-1,inf)
field	MFInt32	normalIndex	
field	SFBool	normalPerVertex	TRUE
field	SFBool	solid	TRUE
field	MFInt32	texCoordIndex	[] #[0,inf)

}

4.3.7.2.2 Functionality and semantics

An **IPRS** node has exactly the same fields as an **IRS** one, except for the physical size information of printout, and **region** field, which has been replaced by **printingMaterialRegion**.

4.3.7.3 PrintingRegion node

4.3.7.3.1 Node interface

PrintingRegion {

exposedField	MFInt32	printingMaterialType	NULL	
exposedField	SFFloat	surfaceThickness	#unit is unit	
exposedField	SFNode	color	NULL	
exposedField	SFNode	normal	NULL	
exposedField	SFNode	texCoord	NULL	
exposedField	SFNode	colorTexture	NULL	
exposedField	SFNode	printingMaterialTexture	NULL	
exposedField	SFNode	textureTransform	NULL	
field	MFInt32	colorIndex	[]	#[-1,inf)
field	MFInt32	coordIndex	[]	#[-1,inf)
field	MFInt32	normalIndex	[]	#[-1,inf)
field	MFInt32	texCoordIndex	[]	#[0,inf)
field	MFInt32	printingMaterialTexCoordIndex	[]	#[0,inf)

}

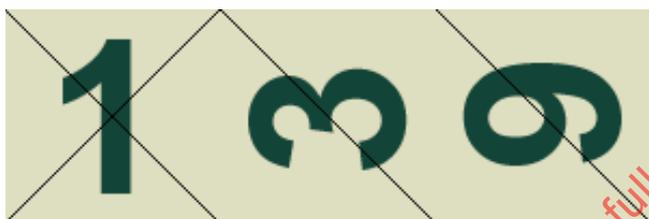
4.3.7.3.2 Functionality and semantics

field name	semantic
unit	It has single string value which shall be one of the length unit defined in the ISO/IEC 23005-6 (UnitTypeCS). It defines the unit of the coord field. When this value is set as mm, all the coord values are interpreted as mm (millimetre).
surfaceThickness	It defines the suggested surface thickness of the model. For example, a cylinder model with 5 surfaceThickness is interpreted as "Print the cylinder with 5 mm surface and leave the inside empty." Here, the unit for surfaceThickness is the same as unit files.
minimumVerticalResolution	It defined the resolution for the acquisition process. When the model is designed based on the scanner, the scanner resolution is mentioned here. When this field is set as 0.1, the 3D printing resolution which is smaller than minimumVerticalResolution does not make sense. In this way, the printing resolution may be estimated. Here, the unit for minimumVerticalResolution is the same as unit files.
printingRegions	It has PrintingRegion node which defined the physical material characteristics of print-out. It has multiple nodes. When a single element is provided, the whole model is considered as one region.
printingMaterialType	It has multiple integers that defines the printing materials of print-out as a reference to a classification defined in ISO/IEC 23005-6 (Printing-MaterialCS). When a single material is provided, the whole region is printed as one material.

field name	semantic
<i>colorTexture</i>	It defines the color texture used in each region for rendering purpose.
<i>printingMaterialTexture</i>	It defines the printing material texture map used in each region. It shall be lossless gray image format such as PNG because the lossy compression results in a misunderstanding on the printing material information. And the values in the image are restricted by <i>printingMaterialType</i> . All values in the printing material texture are one value in the <i>printingMaterialType</i> array. For example, when the <i>printingMaterialType</i> is provided as [0, 1, 2], the <i>printingMaterialTexture</i> shall has values among 0, 1, and 2. When the array length of <i>printingMaterialType</i> is 1, the <i>printingMaterialTexture</i> is null because this region is printed as a single material with <i>printingMaterialType</i> .
<i>texCoordIndex</i>	It defines the texture coordinate indexes of <i>colorTexture</i> .
<i>printingMaterialTexCoordIndex</i>	It defines the texture coordinate indexes of <i>printingMaterialTexture</i> . When this is null, <i>texCoordIndex</i> is used as <i>printingMaterialTexCoordIndex</i> .

4.3.7.4 Examples

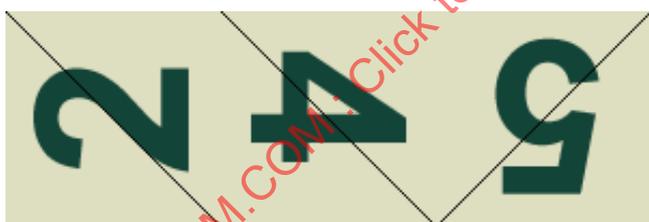
The following examples are based on the IRS representation described in 4.3.6.4.3. It has two printingRegion and each printingRegion has *colorTexture* and *printingMaterialTexture* as illustrated in Figure 25.



a) colorTexture(136.png)

1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	1	1	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0
0	0	1	1	1	1	0	0	0	0	2	2	1	1	0	0	0	0	0	0
0	0	0	1	1	1	0	0	0	2	2	2	1	1	1	0	0	0	0	0
0	0	0	0	1	1	0	0	2	2	2	2	1	1	1	1	0	0	0	0
0	0	0	0	0	1	0	2	2	2	2	2	1	1	1	1	1	0	0	0

b) printingMaterialTexture(136_material.png)



c) colorTexture(245.png)

2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

d) printingmaterialTexture(245_material.png)

Figure 25 — IPRS example with two printingRegion;

In this example, three materials [0, 1, 2] are used thus the values in the printingMaterialTexture are restricted by 0, 1 and 2.

```
IndexedPrintingRegionSet{
  unit "mm"
  minimumVerticalResolution 0.1
  coord Coordinate {
    point [ 0 0 0, 1 0 0, 1 1 0, 0 1 0, 0 1 1, 0 0 1, 1 0 1, 1 1 1, 0.5 0.5 0 ]
  }
  texCoord TextureCoordinate {
    point [ 0 0, 0.333 0, 0.667 0, 1 0, 0 1, 0.333 1, 0.667 1, 1 1, 0.1667 0.5 ]
  }
  printingRegions [
    PrintingRegion {
      surfaceThickness 10.0
      printingMaterialType [0, 1, 2]
      coordIndex [ 2 1 8 -1, 1 0 8 -1, 0 3 8 -1, 3 2 8 -1, 6 5 0 -1, 0 1 6 -1, 5 6 7 -1,
7 4 5 -1 ]
      texCoordIndex [5 1 0 4 7 6 2 3 8]
      colorTexture ImageTexture { url "../pix/136.png" }
      printingMaterialTexture ImageTexture { url "../material/136_material.png" }
    }
    PrintingRegion {
      surfaceThickness 15.0
      printingMaterialType [0, 1, 2]
      coordIndex [4 3 0 -1, 0 5 4 -1, 1 2 7 -1, 7 6 1 -1, 3 4 7 -1, 7 2 3 -1]
      texCoordIndex [4 7 6 5 1 0 3 2]
      colorTexture ImageTexture { url "../pix/245.png" }
      printingMaterialTexture ImageTexture { url "../material/245_material.png" }
    }
  ]
}
```

Page 273, Clause 6

Insert the following clause.

6 Web3D Coding

6.1 General

This document describes a scene representation using a JSON schema. The reason for choosing JSON is the native support by modern browsers and easiness of integration with javascript. The JSON schema is used to connect the object 2graph elements, MPEG AFX tools, images and shaders. The main components of the library (see Figure 82) are the JSON parser and the GraphicsCodec, whereas the GraphicsCodec contains both the SC3DMC and BBA decoders. The input of the library is the JSON description file. The JSON Parser analyses its data and calls the appropriate decoders, the SC3DMC decoder for the mesh data and BBA decoder for the animated data. The output of the decoders is then used to initialize the corresponding glIndexedFaceSet structures that are then used by the WebGL engine to render the scene.

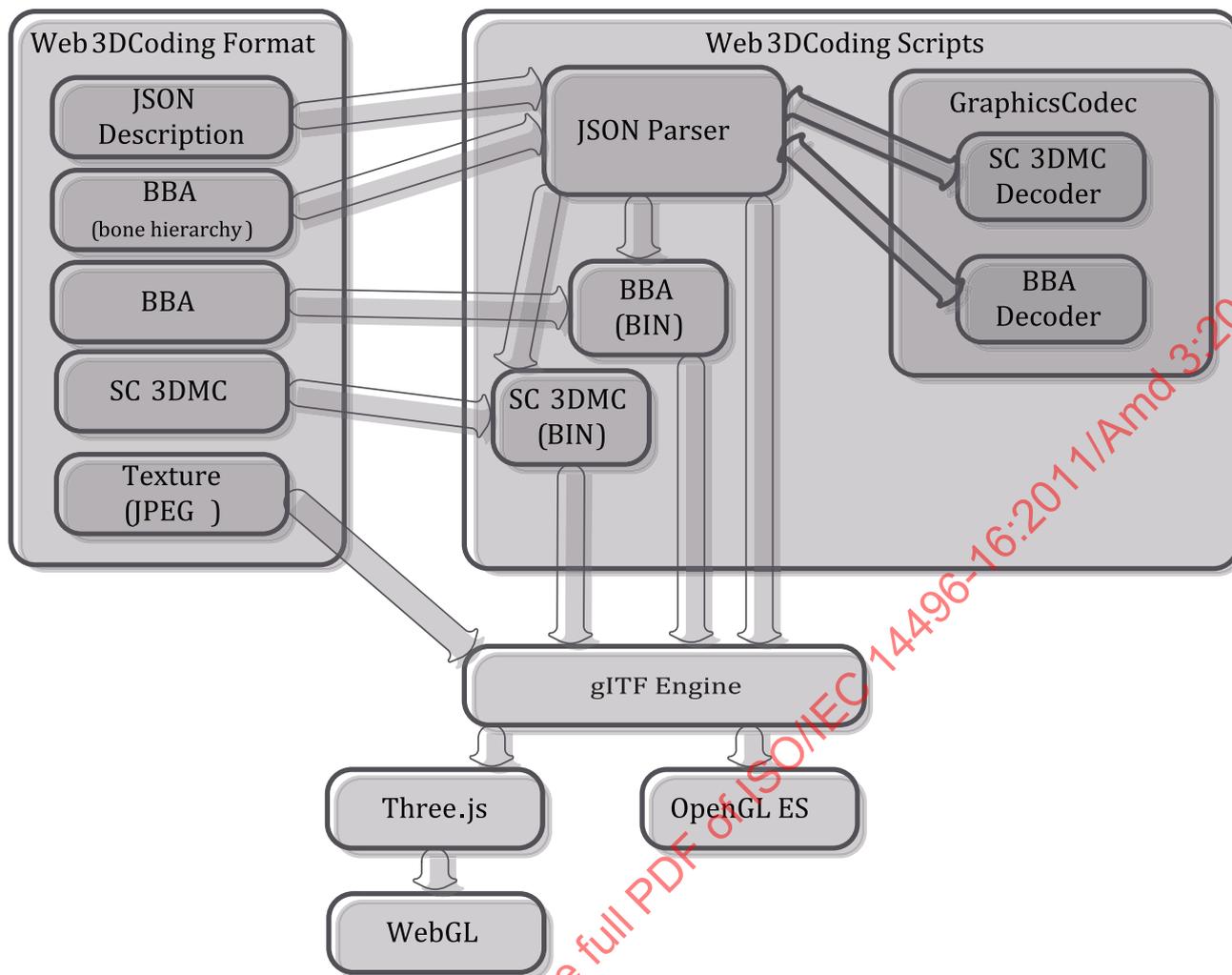


Figure 82 — Overview of the Web3DCoding architecture

6.2 Scope

Define a JSON schema that allows connections between object graph elements to MPEG 4 AFX compression tools (SC3DMC and BBA), image compression tools (JPEG, JPEG2000 and PNG) and shaders.

6.3 JSON Schema

```

{
  "type": "object",
  "properties": {
    "object": {
      "type": "object",
      "properties": {
        "name": {
          "type": "string",
          "description": "The name of the object. The name has to be unique in the object definition"
        },
        "shapes": {
          "type": "array",
          "items": {
            "type": "object",
            "properties": {
              "geometry_filename": {
                "type": "string",
              }
            }
          }
        }
      }
    }
  }
}
  
```

```

        "description" : "An URL to the file containing the 3D mesh
        compressed (MPEG-SC3DMC) data for the shape"
    },
    "transform": {
        "type" : "array",
        "items" : {
            "type" : "number"
        },
        "description" : "An Array of values representing the transformation
        matrix specifying the transformation of the shape relative to the object
        center."
    },
    "appearance" : {
        "type" : "object",
        "properties" : {
            "lineProperties" : {
                "type" : "object",
                "properties" : {
                    "applied" : {
                        "type" : "boolean",
                        "description" : "Specifies if the additional properties
                        shall be applied to all the line geometry."
                    },
                    "linetype" : {
                        "type" : "number",
                        "description" : "Selects a line pattern as defined in the
                        Table 77. Line type 1 is the default. X3D. If a
                        linetype that is not supported is requested, linetype 1
                        shall be used."
                    },
                    "linewidthScaleFactor" : {
                        "type" : "number",
                        "description" : "is a multiplicative value that scales a
                        browser dependent nominal linewidth by the linewidth scale
                        factor. This resulting value shall then be mapped to the
                        nearest available line width. A value less than or equal
                        to zero refers to the minimum available line width.."
                    }
                },
                "description" : "Specifies additional properties to be applied
                to all line geometry."
            },
            "materials" : {
                "type" : "object",
                "properties" : {
                    "diffuseColor" : {
                        "type" : "array",
                        "items" : {
                            "type" : "number"
                        },
                        "description" : "An array of values, reflects all light
                        sources depending on the angle of the surface with
                        respect to the light source. The more directly the
                        surface faces the light, the more diffuse light reflects"
                    },
                    "emissiveColor" : {
                        "type" : "array",
                        "items" : {
                            "type" : "number"
                        },
                        "description" : "An array of values, represents the
                        Models <<glowing>> objects. This can be useful for
                        displaying pre-lit models (where the light energy of the
                        room is computed explicitly), or for displaying
                        scientific data."
                    },
                    "shininess" : {
                        "type" : "number",

```

```

        "description" : "Determine the specular highlights (e.g.,
        the shiny spots on an object). Lower shininess values
        produce soft glows, while higher values result in
        sharper, smaller highlights"
    },
    "specularColor" : {
        "type" : "array",
        "items" : {
            "type" : "number"
        },
        "description" : "An array of values. When the angle from
        the light to the surface is close to the angle from the
        surface to the viewer, the specularColor is added to the
        diffuse and ambient colour calculations."
    },
    "transparent" : {
        "type" : "boolean",
        "description" : "Defines whether this material is
        transparent"
    },
    "opacity" : {
        "type" : "number",
        "description" : "Specifies how 'clear' an object is,
        with 0.5 being a bit transparent"
    }
},
"description" : "An array of materials, one for each sub-shape of
the shape."
},
"shaders" : {
    "type" : "array",
    "items" : {
        "type" : "object",
        "properties" : {
            "activate" : {
                "type" : "boolean",
                "description" : "A Specifies if the current shader is
                active or not."
            },
            "isSelected" : {
                "type" : "boolean",
                "description" : "Indicates that this shader instance
                is the one selected for use by the browser."
            }
        },
        "isValid" : {
            "type" : "boolean",
            "description" : "Indicates whether the current shader objects
            can be run as a shader program."
        },
        "language" : {
            "type" : "string",
            "description" : "Indicates to the browser which shading
            language is used for the source file. This field may be used
            as a hint for the browser if the shading language is not
            immediately determinable from the source (e.g., a generic
            MIME type of text/plain is returned). A browser may use this
            field for determining which node instance will be selected
            and to ignore languages that it is not capable of supporting.
            Three basic language types are defined for this specification
            and others may be optionally supported by a browser.."
        },
        "shader_fileName" : {
            "type" : "string",
            "description" : "An URL pointing to the shader definition
            file in the specified language."
        }
    },
    "required" : ["activate", "isSelected", "isValid", "language",
    "shader_fileName"]
}

```

```

    },
    "texture_fileName" : {
        "type" : "string",
        "description" : "An URL pointing to the texture for the material."
    },
    "textureTransform" : {
        "type" : "object",
        "properties" : {
            "center" : {
                "type" : "array",
                "items" : {
                    "type" : "number"
                },
                "description" : "Specifies a translation offset in texture
                coordinate space about which the rotation and scale fields are
                applied."
            },
            "rotation" : {
                "type" : "number",
                "description" : "Specifies a rotation in radians of the texture
                coordinates
                about the center point after the scale has been applied. A
                positive rotation value makes the texture coordinates rotate
                counterclockwise about the centre, thereby rotating the appearance
                of the texture itself clockwise."
            },
            "scale" : {
                "type" : "number",
                "description" : "Specifies a scaling factor in S and T of the
                texture coordinates about the center point."
            },
            "translation" : {
                "type" : "array",
                "items" : {
                    "type" : "number"
                },
                "description" : "Specifies a translation of the texture
                coordinates."
            }
        }
    },
    "description" : "specifies the visual properties of geometry"
},
"anm" : {
    "type" : "array",
    "items" : {
        "type" : "object",
        "properties" : {
            "numFrames" : {
                "type" : "number",
                "description" : "Specifies the number of frames for the current set
                of properties."
            },
            "localCoordinates" : {
                "type" : "boolean",
                "description" : "Specifies if the bone transforms are
                represented in local coordinates."
            },
            "skeleton" : {
                "type" : "array",
                "items":{
                    "type" : "object",
                    "properties" : {
                        "numBones" : {
                            "type" : "number",
                            "description" : "Specifies the number of bones in
                            the current skeleton."
                        }
                    }
                }
            }
        }
    }
}

```

```

    },
    "bones" : {
      "type" : "array",
      "items" : {
        "type" : "object",
        "properties" : {
          "boneID" : {
            "type" : "number",
            "description" : "Specifies the unique
              id of the bone."
          },
          "parentID" : {
            "type" : "number",
            "description" : "Specifies the parent
              bone unique id of the bone."
          },
          "boneTransform" : {
            "type" : "array",
            "items" : {
              "type" : "number"
            },
            "description" : "Array of values
              representing the transform matrix of
              size 4x4 represented as 16 values
              array."
          }
        }
      }
    },
    "description" : "Array of objects of type <<bones>>."
  }
}

},
"required" : ["numFrames", "localCoordinates", "skeleton"]
},
"required" : ["numFrames", "localCoordinates", "skeleton"],
"description" : "An optional field describing the connection between the
  bones and the vertices."
},
"animation" : {
  "type" : "object",
  "properties" : {
    "bba_streams" : {
      "type" : "array",
      "items" : {
        "type" : "object",
        "properties" : {
          "name" : {
            "type" : "string",
            "description" : "A name for the animation. It has to
              be unique for the shape object."
          },
          "animation_fileName" : {
            "type" : "string",
            "description" : "An URL pointing to the BBA file
              that corresponds to the animation."
          }
        }
      }
    },
    "required" : ["name", "animation_fileName"]
  },
  "description" : "An array of BBA animation streams associated
    with the shape."
},
}
},

```