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Industrial automation systems and integration — JT file format specification for 3D visualization

Systèmes d'automatisation industrielle et intégration — Spécification de format de fichier JT pour visualisation 3D

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Foreword

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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 ISO documents 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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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*.

This second edition cancels and replaces the first edition (ISO 14306:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

- addition of a STEP B-Rep Segment based on the ISO 10303 STEP suite of standards;
- addition of a new geometry chapter listing all geometry segments in the annexes;
- updates of the documentation from the ProSTEP iViP industrialization guidelines;
- addition of a conformance clause;
- addition of a mapping table JT ISO to STEP;
- deprecation of the JT Brep segment;
- deprecation of the PMI data segment which is superseded by the meta data segment.

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Introduction

The ISO 14306 format is an industry focused, high-performance, lightweight, flexible file format for capturing and repurposing 3D product definition data for visualization to enable collaboration and validation throughout the extended enterprise. The ISO 14306 format is streamable and contains compression for compact and efficient representation.

Some of the highlights of the ISO 14306 format include:

- built-in support for assemblies, sub-assemblies and part constructs;
- a flexible partitioning scheme, supporting single or multiple files;
- b-rep solid shape representations to provide precision to the light-weight viewing processes;
- product manufacturing information in support of paperless manufacturing initiatives;
- precise and imprecise wireframe shape representations;
- discrete purpose-built levels of detail;
- triangle sets, polygon sets, point sets, line sets and implicit primitive sets (such as cylinder, cone and sphere);
- a full array of visual attributes such as for materials, textures, lights;
- hierarchical bounding box and bounding spheres;
- data compression that allows producers of JT files to fine tune the trade-off between compression ratio and fidelity of the data.

Beyond the data contents description of the ISO 14306 format, the overall physical structure/organization of the format is also designed to support operations such as:

- offline optimizations of the data contents, i.e. file granularity and flexibility optimized to meet the needs of enterprise data translation solutions;
- asynchronous streaming of content, i.e. viewing optimizations such as view frustum and occlusion culling and fixed-framerate display modes;
- layers, and layer filters.

NOTE This document is based on the JT Open version 9.5 specification, which defines a scene graph with geometry specific node and attribute support, extended to support ISO 10303.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents USA 20110199382, 8019788.

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Industrial automation systems and integration — JT file format specification for 3D visualization

1 Scope

This document defines the syntax and semantics of a file format for the 3D visualization and interrogation of lightweight geometry and product manufacturing information derived from CAD systems, using visualization software tools that do not need the full capability of a CAD system.

This document has been adopted as a 3D visualization capability in addition to the ISO 10303 series.

The ISO 10303 series are the ISO standards adopted for the engineering data exchange, sharing and long term archiving of product definition information throughout the product lifecycle.

In this document 3D visualization is defined as the visual presentation on a screen or another media of graphical and textual 3 dimensional representations of a set of data representing an object, information or results of a computational process in order to enable decision process by a human looking at the data visualized in a medium.

The file format supports the following information:

- facet information (triangles), stored with geometry compression techniques
- visual attributes such as lights, textures and materials
- product manufacturing information, such as dimensions, tolerances and other attributes
- boundary representation (b-rep) solid model shape representations. Several alternatives are available, including a representation based on the geometry standard defined in ISO 10303
- configuration representations
- delivery methods such as asynchronous streaming of content

The document does not specify the implementation of, or definition of a run-time architecture for viewing or processing of the file format.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10303-21:2014, *Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of the exchange structure*

ISO 10303-42:2014, *Industrial automation systems and integration – Product data representation and exchange – Part 42: Integrated generic resource: geometric and topological representation*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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3.1.1
3D visualization
visual presentation on a screen or another media of graphical and textual three dimensional representations of a set of data representing an object, information or results of a computational process in order to facilitate capture of the understanding of the object, for visual information sharing with users and sometimes to promote decision process by a human looking at the data visualized in a medium

3.1.2
assembly
related collection of model parts, represented in a ISO 14306 format logical scene graph as a logical graph branch

3.1.3
attribute
objects associated with nodes in a logical scene graph and specifying one of several appearances, positioning, or rendering characteristics of a shape

3.1.4
code text
collection of data in encoded form

3.1.5
coordinate system
system which uses one or more numbers, or coordinates, to uniquely determine the position of a point or other geometric element

Note 1 to entry: If not otherwise specified in a data field's description, it is assumed that the data is defined in Local Coordinate System.

3.1.6
degenerated surface
place where a region of the parameter space of the surface is mapped to a single point of Cartesian space

Note 1 to entry: This means that there are several (u,v) parameters defining the same 3D point of the surface. In this region, one or both first partial derivatives are zero. The tip of a cone or the poles of a sphere are common examples.

3.1.7
directed acyclic graph
graph that consists of a set of nodes and a set of edges that connect the nodes in a tree like structure

Note 1 to entry: A directed graph is one in which every edge has a direction such that edge (u,v), connecting node-u with node-v, is different from edge (v,u).

Note 2 to entry: A directed acyclic graph is a directed graph with no cycles, where a cycle is a path (sequence of edges) from a node to itself.

Note 3 to entry: With a directed acyclic graph, there is no path that can be followed within the graph such that the first node in the path is the same as the last node in the path.

3.1.8
JT enabled application
application which supports reading and/or writing reference compliant ISO 14306 format files

3.1.9
level of detail
LOD
alternative graphical representation for some model component such as part

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3.1.10
local coordinate system
LCS
coordinate system that is used to specify the raw data of the shape geometry with no transforms applied

3.1.11
logical scene graph
LSG
scene graph representing the logical organization of a model

Note 1 to entry: A scene graph contains shapes and attributes representing the model's physical components, properties identifying arbitrary metadata (e.g. names, semantic roles) of those components, and a hierarchical structure expressing the component relationships.

3.1.12
mipmap
reduced resolution version of a texture map

Note 1 to entry: Mipmaps are used to texture a geometric primitive whose screen resolution differs from the resolution of the source texture map originally applied to the primitive.

3.1.13
model
representation, in ISO 14306 format, of a physical or virtual product, part, assembly; or collections of such objects

3.1.14
model coordinate system
MCS
local coordinates transformed by any transforms specified as attributes at or above the node

3.1.15
product and manufacturing information
PMI
collection of information created on a 3D/2D CAD model to completely document the product with respect to design, manufacturing, inspection, etc.

Note 1 to entry: This can include data such as:

— dimensions (tolerances for each dimension);

— geometric tolerances of feature (datums, feature control frames);

— manufacturing information (surface finish, welding notations);

— inspection information (key locations points);

— assembly instructions;

— product information (materials, suppliers, part numbers).

3.1.16
property
object associated with a logical scene graph node and identifying arbitrary application or enterprise specific information (meta-data) related to that node

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3.1.17
quantize
constrain something to a discrete set of values, such as an integer or integral multiplier of a common factor, rather than a continuous set of values, such as a real number

3.1.18
scene graph
directed acyclic graph that arranges the logical and often (but not necessarily) spatial representation of a graphical scene

3.1.19
shader
user-definable program, expressed directly in a target assembly language or in high-level form to be compiled, that calculates colour values at a pixel based upon data such as lighting, surface colour and texture

Note 1 to entry: A shader program replaces a portion of the otherwise fixed-functionality graphics pipeline with some user-defined function.

Note 2 to entry: At present, hardware manufacturers have made it possible to run a shader for each vertex that is processed or each pixel that is rendered.

3.1.20
streaming
loading from disk based medium only the portions of data that are required by the user to perform the tasks at hand

Note 1 to entry: The motivation for sreaming is to more efficiently manage system memory.

Note 2 to entry: Transfer of data in a stream of packets, over the internet on an on-demand basis, where the data is interpreted in real-time by the application as the data packets arrive.

Note 3 to entry: The motivation for streaming is that the user can begin using or interacting with the data almost immediately - no waiting for the entire data file(s) to be transferred before beginning.

Note 4 to entry: The desired end result of streaming is to deliver only the ISO 14306 data that the user needs, where the user needs it, when the user needs it.

3.1.21
shape
logical scene graph leaf node containing or referencing the geometric shape definition data (such as vertices, polygons and normals) of a model component

3.1.22
texture channel
texture unit plus the texture environment

Note 1 to entry: The ISO 14306 format meaning for texture channel is the same as in OpenGL [1].

3.1.23
texture object
named cache that stores texture data, such as the image array, associated mipmaps, and associated texture parameter values: width, height, border width, internal format, resolution of components, minification and magnification filters, wrapping modes, border colour, and texture priority

Note 1 to entry: The ISO 14306 format meaning for texture object is the same as in OpenGL [1].

3.1.24
texture unit
piece of hardware that takes a sample of a texture

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Note 1 to entry: The ISO 14306 format meaning for texture unit is the same as in OpenGL [1].

3.1.25
view coordinate system
world coordinates transformed by a view matrix

3.1.26
world coordinate system
WCS
node coordinates transformed by transforms inherited from a node's parent (i.e. the coordinate system at the root of the graph)

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

Abs	Absolute Value
Bbox	Bounding Box
B-Rep	Boundary Representation
CAD	Computer Aided Design
CODEC	Coder-Decoder
GD&T	Geometric Dimensioning and Tolerancing
GUID	Globally Unique Identifier
HSV	Hue, Saturation, Value
JT	Jupiter Tesselation
LsbFirst	Least Significant Byte First
Max	Maximum
Min	Minimum
MsbFirst	Most Significant Byte First
N/A	Not Applicable
PCS	Parameter Coordinate Space
PLM	Product Lifecycle Management
RGB	Red, Green, Blue
RGBA	Red, Green, Blue, Alpha
TOC	Table of Contents
URL	Uniform Resource Locator

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