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Information ~~Technology~~ technology — Computer graphics, image processing and environmental data representation — Guidelines for ~~Representation~~representation and ~~Visualization~~visualization of ~~Smart Cities~~smart cities

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A model manuscript of a draft International Standard (known as "The Rice Model") is available at https://www.iso.org/iso/model_document-rice_model.pdf

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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~~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~~ 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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For an explanation of 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 www.iso.org/iso/foreword.html~~) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information ~~and Communications Technology~~technology*, Subcommittee SC 24, *Computer graphics, image processing and environmental data representation*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at ~~www.iso.org/members.html~~www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

Developers and users of a smart city need tools to evaluate and examine options and trade-offs and predict outcomes. Parts or all of a smart city may need to be modelled, and smart city functions need to be simulated to evaluate possible outcomes. The modelling and simulation of smart city functions and processes require representation and visualization of the data. Representation and visualization of smart cities enable prototyping, demonstration and analysis of smart city concepts for further development. Both physical/geometric and semantic data can be represented and visualized. Representation and visualization of smart cities is a prime application for an integrated approach to leverage standardization since no single standard may address all requirements. This document provides guidance as to what needs to be represented for smart cities and how this can be achieved.

This document describes categories of data associated with smart cities and guidelines for their representation and visualization. It describes how standards can be applied to represent and visualize urban infrastructure, services and features. Use cases are presented that explore how these standards could be applied in smart city analysis and visualization applications.

Information technology — Computer graphics, image processing and environmental data representation — Guidelines for representation and visualization of smart cities

1 Scope

This document ~~provides~~specifies guidelines for the representation and visualization of smart cities. This document:

a) describes the concepts of a smart city, smart city object and smart city data,

b) describes categories of data associated with smart cities,

c) provides guidance for representation of smart cities,

d) describes guidance for visualization of smart cities,

e) provides guidance in selecting the appropriate representation and visualization technique for different categories of smart city data using standards, and

f) provides use cases for applying standards to the representation and visualization of smart cities.

2 Normative references

There are no normative references in the document.

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 terminology databases for use in standardization at the following addresses:

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

— ~~—~~IEC Electropedia: available at ~~https://www.electropedia.org/~~https://www.electropedia.org/

3.1.1
3D city model
representation of an urban environment with a 3D geometry of typical or specific urban objects and structures, with buildings as the most prominent features

3.1.2
analytical data
data that has been derived from properties or applications of a smart city

Note ~~1~~ to entry: Examples of analytical data include data describing car traffic and pedestrian movements obtained from sensors.

3.1.3
big data
extensive datasets, primarily with characteristics of volume, variety, velocity and/or variability, that require a scalable technology for efficient storage, manipulation and analysis

Note 1 to entry: big data is commonly used in many different ways, for example as the name of the scalable technology used to handle big data extensive datasets.

[SOURCE: ISO/IEC 20546:2019, 3.1.2]

3.1.4
built environment
human-made environment that includes buildings, roads, bridges, tunnels and city artefacts

3.1.5
Data Representation Model
DRM
standardized representation of the relationships and organization of environmental objects and content within SEDRIS ~~(ISO/IEC 18023 series)~~

Note 1 to entry: SEDRIS refers to the ISO/IEC 18023 series.

3.1.6
Internet of Things
IoT
infrastructure of interconnected objects, people, systems and information resources together with intelligent services to allow them to process information of the physical and the virtual world and to react

~~{~~[SOURCE: ISO/IEC 23093-1:~~2020(en),~~2022, 3.2.9]

3.1.7
physical property
measurable quantity that describes the state of a system

Note 1 to entry: Physical properties can be categorized as mechanical, electrical, optical or thermal and may be scalar values (such as temperature) or vector quantities (such as wind flow).

3.1.8
presentation
organization of data into textual, tabular or graphical format

Note 1 to entry: This can include non-visual modes of presentation such as audio and haptics.

3.1.9
representation
description of a real-world event, system, behaviour or natural phenomenon

Note 1 to entry: In this document, representation refers to the digital description of an event, object or system.

3.1.10
semantic property
property that does not have a physical basis

Note 1 to entry: Building ownership is an example of a semantic property.

3.1.11
smart city
city that increases the pace at which it provides social, economic and environmental sustainability outcomes and responds to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how it engages society, applies collaborative leadership methods, works across disciplines and city systems, and uses data information and modern technologies to deliver better services and quality of life to those in the city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of others or degradation of the natural environment

~~[SOURCE: ISO 37122:2019, 3.4]~~

Note 1 to entry: A virtual smart city is its digital/simulated representation.

~~3.1.1~~
[SOURCE: ISO 37122:2019, 3.4, modified — The original Notes to entry have been deleted and replaced by a new Note to entry.]

3.1.12
smart city data
data that is associated with a smart city

Note 1 to entry: This refers to data that may be consumed or produced by a smart city function or application.

3.1.13
smart city object
representation of a distinct object that is part of a real or virtual smart city

Note 1 to entry: A smart city object may not necessarily contain smart technology. It is used as a general descriptor for a component of a smart city.

3.1.14
spatiotemporal
associated with positions in space and/or time

~~3.1.2~~
3.1.15
visualization
rendering of an object, situation or set of information as a chart or image

Note 1 to entry: Visualization is a subset of presentation restricted to the visual medium.

3.2 Abbreviated terms

2D ~~Two~~two dimensional

3D ~~Three~~three dimensional

API	~~Application~~application programming interface
AR	~~Augmented~~augmented reality
BIIF	~~Basic Image Interchange Format~~basic image interchange format
BIM	~~Building Information Modelling~~building information modelling
CCTV	~~Closed Circuit Television~~closed circuit television
DICOM	~~Digital Imaging~~digital imaging and ~~Communications~~communications in ~~Medicine~~medicine
DIS	~~Distributed Interactive Simulation~~distributed interactive simulation
DRM	~~Data Representation Model~~data representation model
EDCS	~~Environmental Data Coding Specification~~environmental data coding specification
GIS	~~Geospatial Information Systems~~geospatial information systems
GKS	~~Graphical Kernel System~~graphical kernel system
GPS	~~Geospatial Positioning System~~geospatial positioning system
HAnim	~~Humanoid Animation~~humanoid animation
ICT	~~Information and Communications Technology~~information and communications technology
IoT	~~Internet~~internet of ~~Things~~things
JPEG	~~Joint Photographic Experts Group~~joint photographic experts group
JSON	JavaScript object notation
MAR	~~Mixed~~mixed and augmented reality
MPEG	~~Moving Picture Experts Group~~moving picture experts group
OGC	~~Open Geospatial Consortium~~open geospatial consortium
PHIGS	~~Programmer's Hierarchical Interactive Graphics System~~programmer's hierarchical interactive graphics system
PNG	~~Portable Network Graphics~~portable network graphics
SEDRIS	~~Synthetic Environment Data Representation and Interchange Specification~~synthetic environment data representation and interchange specification
SRM	~~Spatial Reference Model~~spatial reference model
VR	~~Virtual~~virtual reality
VRML	~~Virtual Reality Modeling Language~~virtual reality modeling language
~~X3D[1]~~X3D	~~Extensible~~extensible 3D
X3DOM	X3D ~~Document Object Model~~document object model
XML	~~Extensible Markup Language~~extensible markup language

~~[1] X3D is a trademark of the Web3D Consortium. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC.~~

4 Representation and visualization standards

4.1 Standards overview

ISO standards for imagery, environmental representation, visualization and mixed and augmented reality can be applied to smart cities. These are described in the following subsections.

4.2 Representation standards

The SEDRIS series (ISO/IEC 18023~~-1, -2, -3~~ series) provides a suite of standards for environmental representation~~ standard~~. SEDRIS is an infrastructure technology that enables information technology applications to express, understand, share and reuse environmental data. SEDRIS technologies provide the means to represent integrated environmental data (terrain, ocean, air and space), and promote the unambiguous, loss-less and non-proprietary interchange of environmental data. It is a means of organising environmental and feature data, ~~however it~~yet leaves the (graphical) presentation of that data to other applications, such as X3D[2] and other visualization tools. SEDRIS was developed for military training simulation and has mainly been applied in that domain. An introduction to SEDRIS is provided in ~~[1].~~Reference [1].

The components of SEDRIS are:

— functional specification (ISO/IEC 18023-1~~ SEDRIS Part 1: Functional Specification~~)

— abstract transmittal format (ISO/IEC 18023-2~~ SEDRIS Part 2: Abstract Transmittal Format~~)

— transmittal format binary encoding (ISO/IEC 18023-3~~ SEDRIS Part 3: Transmittal Format Binary Encoding~~)

— ~~ISO/IEC 18024-4~~ SEDRIS language bindings – Part 4: C (ISO/IEC 18024-4)

— ~~ISO/IEC 18025 Environmental Data Coding Specification~~environmental data coding specification (EDCS) that provides identification (designation) of objects and their attributes (ISO/IEC 18025)

— ~~ISO/IEC 18026 Spatial Reference Model~~spatial reference model (SRM) that handles position, orientation and spatial reference frames (ISO/IEC 18026)

— ~~Data Representation Model~~data representation model (DRM) that models the relationships between objects and their representations as described in ISO/IEC 18023 series

— ~~Application~~application programming interface (API)as described in ISO/IEC 18023 series

EDCS, DRM and SRM all have ISO/IEC managed registries. The EDCS standard and its corresponding registry contain entries for environmental concepts, objects and attributes, with about ~~1500~~1 500 classifications (types of environmental objects) and ~~1900~~1 900 attributes. These entries include a wide range of environmental concepts, from natural phenomena to human-made objects, and a large array of attributes and units of measure. Many of the EDCS entries are relevant to smart city modelling and simulation, and new entries can be added through registration to ISO as these are required. Since SEDRIS was developed primarily for military environments, a considerable number of entries can be included to populate civilian urban environments.

SEDRIS is extensible through the ISO registration system for EDCS and SRM for new objects, features and coordinate systems. It includes Levels of Detail and georeferencing. While developed for military use SEDRIS can also represent civil assets and systems such as a smart city.

[2] X3D is a trademark of the Web3D Consortium. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC.