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Information technology — Computer graphics and image processing — Conformance testing of implementations of graphics standards

Technologies de l'information — Traitement informatisé de l'image et des graphiques — Essais de conformité de la mise en application des normes graphiques

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 10641 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Sub-Committee SC 24, *Computer graphics and image processing*.

Annexes A and B of this International Standard are for information only.

Introduction

This International Standard addresses conformance testing of implementations of graphics standards. Conformance testing is the method used to determine the adherence or non-adherence of an implementation under test (IUT) to a standard.

This International Standard specifies an approach for testing the conformance to computer graphics standards of products that claim to implement these standards. It addresses the conformance testing processes for all classes of graphics standards.

This International Standard defines a general framework of procedures and guidelines for conformance testing, together with definitions of terms and concepts.

The framework given in this International Standard, together with the Test Requirements document for a particular graphics standard, provides a description of the procedures to be followed to achieve successful conformance testing of products for conformance to a particular graphics standard.

The concept of conformance is central to every standard. The aims and benefits of a standard can be realized if there is a means of testing for conformance.

The main reasons for introducing a document on conformance testing in the area of computer graphics are:

- To promote standards that are developed in a way such that products can be tested for conformance to the standards' requirements;
- To promote that conformance is addressed in each standard;
- To promote test suites that are appropriately defined for testing products for conformance to all areas of the standard, and are of high quality;
- To promote test methods for similar standards that are developed in a consistent way;
- To promote conformance testing that is carried out in a consistent way throughout the international graphics community.

Users of this International Standard include:

- Developers of graphics standards;
- Implementors of graphics standards;
- Developers of graphics test suites;
- Testing laboratories;
- Certification bodies;
- Accreditation bodies.

Annexes A and B contain diagrams illustrating the relationships among the users of this International Standard and the information shared by them.

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Information technology — Computer graphics and image processing — Conformance testing of implementations of graphics standards

1 Scope

This International Standard specifies a general framework for testing conformance to a computer graphics standard. The general framework described in this International Standard addresses the following six components:

- Conformance in the standard itself;
- Test Requirements document, defining what shall be tested for a computer graphics standard;
- Test Specifications document, addressing the test technique and the content of each test;
- Test method, defining the implementation of the Test Specification document, including the test software;
- Test procedures, defining the application of the test software, which consists of the procedures to be used in conformance testing;
- The establishment of test services.

This International Standard is applicable to all standards within the scope of the subcommittee within ISO/IEC JTC1 responsible for computer graphics and image processing.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 7942:1985, *Information processing systems - Computer graphics - Graphical Kernel System (GKS) functional description.*

ISO/IEC 8632-1:1992, *Information technology - Computer graphics - Metafile for the storage and transfer of picture description information -Part 1: Functional specification.*

ISO/IEC 8632-2:1992, *Information technology - Computer graphics - Metafile for the storage and transfer of picture description information -Part 2: Character encoding.*

ISO/IEC 8632-3:1992, *Information technology - Computer graphics - Metafile for the storage and transfer of picture description information -Part 3: Binary encoding.*

ISO/IEC 8632-4:1992, *Information technology - Computer graphics - Metafile for the storage and transfer of picture description information -Part 4: Clear text encoding.*

ISO/IEC 8651-1:1988, *Information processing systems - Computer graphics - Graphical Kernel System (GKS) language bindings - Part 1: FORTRAN.*

ISO/IEC 8651-2:1988, *Information processing systems - Computer graphics - Graphical Kernel System (GKS) language bindings - Part 2: Pascal.*

ISO/IEC 8651-3:1988, *Information processing systems - Computer graphics - Graphical Kernel System (GKS) language bindings - Part 3: Ada.*

ISO/IEC 8651-4:1991, *Information technology - Computer graphics - Graphical Kernel System (GKS) language bindings - Part 4: C.*

ISO/IEC 8805:1988, *Information processing systems - Computer graphics - Graphical Kernel System for Three Dimensions (GKS-3D) functional description.*

ISO/IEC 8806-1:1988, *Information processing - Computer graphics - Graphical Kernel System for Three Dimensions (GKS-3D) language bindings - Part 1: FORTRAN.*

ISO/IEC 8806-4:-[1], *Information technology - Computer graphics - Graphical Kernel System for Three Dimensions (GKS-3D) language bindings - Part 4: C.*

ISO/IEC 9592-1:1989/Amd.1:1992, *Information processing systems - Computer graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) - Part 1: Functional description Amendment 1.*

ISO/IEC 9592-2:1989/Amd.1:1992, *Information processing systems - Computer graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) - Part 2: Archive file format Amendment 1.*

ISO/IEC 9592-3:1989/Amd.1:1992, *Information processing systems - Computer graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) - Part 3: Clear text encoding of archive file Amendment 1.*

ISO/IEC 9592-4:1992, *Information processing systems - Computer graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) - Part 4: Plus Lumiere und Surfaces, PHIGS PLUS.*

1) To be published.

ISO/IEC 9593-1:1990, *Information processing systems - Computer graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) language bindings - Part 1: FORTRAN.*

ISO/IEC 9593-3:1990, *Information technology - Computer graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) language bindings - Part 3: Ada.*

ISO/IEC 9593-4:1992, *Information technology - Computer graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) language bindings - Part 4: C.*

ISO/IEC 9636-1:1991, *Information technology - Computer graphics - Interfacing techniques for dialogues with graphical devices (CGI) - Functional specification - Part 1: Overview, profiles and conformance.*

ISO/IEC 9636-2:1991, *Information technology - Computer graphics - Interfacing techniques for dialogues with graphical devices (CGI) -Functional specification - Part 2: Control.*

ISO/IEC 9636-3:1991, *Information technology - Computer graphics - Interfacing techniques for dialogues with graphical devices (CGI) - Functional specification - Part 3: Output.*

ISO/IEC 9636-4:1991, *Information technology - Computer graphics - Interfacing techniques for dialogues with graphical devices (CGI) - Functional specification - Part 4: Segments.*

ISO/IEC 9636-5:1991, *Information technology - Computer graphics - Interfacing techniques for dialogues with graphical devices (CGI) - Functional specification - Part 5: Input and echoing.*

ISO/IEC 9636-6:1991, *Information technology - Computer graphics - Interfacing techniques for dialogues with graphical devices (CGI) - Functional specification - Part 6: Raster.*

ISO/IEC 9637-1:-[2], *Information technology - Computer graphics - Interfacing techniques for dialogues with graphical devices (CGI) - Data stream binding - Part 1: Character encoding.*

ISO/IEC 9637-2:1992, *Information technology - Computer graphics - Interfacing techniques for dialogues with graphical devices (CGI) - Data stream binding - Part 2: Binary encoding.*

ISO/IEC 11072:1992, *Information technology - Computer graphics - Computer Graphics Reference Model.*

ISO/IEC Guide 2:1991, *General terms and their definitions concerning standardization and related activities.*

ISO/IEC Guide 23:1982, *Methods of indicating conformity with standards for third-party certification systems.*

ISO/IEC Guide 25:1990, *General requirements for the competence of calibration and testing laboratories.*

ISO/IEC Guide 28:1982, *General rules for a model third-party certification system for products.*

ISO/IEC Guide 45:1985, *Guidelines for the presentation of test results.*

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2) To be published.

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 accreditation: Formal recognition that a testing laboratory is competent to carry out specific tests or specific types of tests.

3.2 accreditation body: A body which conducts and administers a laboratory accreditation system and grants accreditation.

3.3 application programmer interface (API) standard: A standard which provides an application-oriented programming interface.

3.4 candidate implementation: Implementation that is tested for conformance to a given standard.

3.5 certificate (of conformity): A document attesting that a product or a service is conforming to one or more specific standards or technical specifications.

3.6 certification: Procedure resulting in the issuance of a certificate.

3.7 certification body: Body that conducts certificates of conformity "[ISO/IEC Guide 2]"; body that issues certificates of conformity.

3.8 certification criteria: Criteria that determine whether a certificate is issued.

3.9 client: Anyone requesting conformance testing.

3.10 configuration: An interleaved combination of hardware and software including the host computer, the host operating system, the device-independent graphics package, the device driver handling graphical input/output on a specific device and the programming language.

3.11 conformance: Fulfillment by a product, process or service of all requirements specified "[ISO/IEC Guide 2, conformity]"; adherence of an implementation to the requirements of one or more specific standards or technical specifications.

3.12 conformance testing: Test to evaluate the adherence or non-adherence of a candidate implementation to a standard.

3.13 data stream encoding: Specific representation of the syntax of a graphics standard suitable for use over a data interface.

3.14 essential feature: Features that, when grouped together, perform a minimal set of operations expected by a standard.

3.15 falsification: Test method that attempts to find errors in a candidate implementation to determine if it is incorrect.

3.16 full conformance: The implementation of all required features error-free.

3.17 implementation conformance: Description of what is required of implementors in order to have the implementation conform to a standard.

3.18 implementation under test (IUT): A candidate implementation being tested.

3.19 language binding: The programmer's interface to the functions in a graphics system through a programming language.

3.20 metafile standards: Standards defining graphical elements and corresponding encodings for storage and transfer of graphical information.

3.21 minimal conformance: The implementation of all essential features error-free.

3.22 operator: The external object that observes the contents of the display and generates physical input values.

3.23 operator interface: Interface provided by the physical environment to the operator.

3.24 program conformance: Description of what is required of a program in order to conform to a standard.

3.25 test case: Smallest unit of a test program that tests one feature of a candidate implementation.

3.26 test method: Specified technical procedure for performing a test "[ISO/IEC Guide 2]"; a defined technical procedure used to design a test suite for a given standard.

3.27 test procedures: Defines the procedures to be followed when applying a test suite to a product for the purposes of conformance testing.

3.28 test program: A program consisting of a set of test cases.

3.29 test report: A document that presents the test results and other information relevant to the tests (e.g., configuration description and detected errors).

3.30 test requirements document: Describes the features and functions defined in a particular standard to which a candidate implementation shall be tested for conformance.

3.31 test result: Output of a test case.

3.32 test script: Document describing the test software and its various test cases for operator guidance and decision support.

3.33 test service: Service offered by testing laboratories.

3.34 test specifications document: Describes procedures, tools and test cases that are used to fulfill requirements in the Test Requirements document.

3.35 test software: Set of test programs and corresponding documentation that are used for conformance testing.

3.36 test suite: The combination of test software, test documentation, and test procedures that check an implementation for conformance to a standard.

3.37 testing control board: A board of experts in standards and testing set up for each group or type of products to address problems raised as a result of conformance testing.

3.38 testing laboratory: Laboratory that performs tests "[ISO/IEC Guide 2]"; a laboratory that measures conformance of implementations of standards to a group or type of standards.

3.39 testing support service: Organization responsible for a particular test service (e.g., maintenance of test suite, licensing).

3.40 validation: Testing for conformance.

3.41 verification: Method to prove the correctness of a candidate implementation against standards or technical specifications.

4 Overview

Correct utilization of standards allows applications to be moved among different computers and graphics devices with minimal change. The degree of portability achieved is affected by the degree of support for the same sets of functions, levels, and implementation dependent features of an implementation. Conformance testing using test suites encourages implementors to use the standards correctly by checking for deviations and omissions from the standards. When all deviations and omissions are eliminated, the implementation conforms to the standard. This greatly diminishes or removes the work involved to achieve portability between dissimilar systems. In many countries, an implementation of a standard that has obtained a certificate is favoured for purchase by the public. In addition, the certificate may be mandated for sales into certain markets, such as the government.

Even before a standard becomes official, there is a strong effort to implement products that (claim to) conform to the proposed standard. This is because even draft standards create a strong user demand. For example, vendors started advertising implementations of an ISO graphics standard at least one year before the standard was actually approved by ISO/IEC. Shortly after that, these implementations were available on the marketplace. Without defined test methods, some of these packages bear only superficial resemblance to a correct implementation of the standard. Other implementations might conform to many aspects of the standard but might still be deficient in subtle areas. Thus, test suites that test implementations to determine conformance to standards are needed.

4.1 Conformance testing

Conformance testing is a way of scrutinizing implementations of a computer standard to determine whether or not deviations from the standard exist. Standards usually contain two main ingredients: semantics and syntax. The semantics is the functional description that defines precisely what must be done, but not how it is to be done. The syntax defines the mechanism by which these functions can be accessed. Syntax may consist of verbs in a programming language to access the function, or (in the case of computer graphics standards) language bindings to access the graphics functions. Syntax may also take the form of data stream encodings for data interchange standards.

However, a third ingredient is sometimes overlooked in standards - **conformance**. The conformance or classification and designation clause, in conjunction with the test of the standard, specifies the requirements an implementor shall adhere to in order to conform to the standard and sets the groundwork for the development of conformance tests.

A test suite is the combination of test software, test script, and test procedures, all of which check an implementation for conformance to a standard.

The approach usually used in developing test suites for testing conformance of implementations is called falsification testing. This method uses sample cases that test as many of the requirements of the standard as are feasible. A test suite tries to find errors in the implementation. If errors are found, one can correctly deduce that the implementation does not conform to the standard. However, the absence of errors does not necessarily prove that the implementation is correct. The absence of errors implies either that the implementation conforms to the standard or that the test suite was not comprehensive enough to find errors. Thus, falsification testing can determine non-conformance to a standard but can never assure complete conformance. Falsification testing is the method used to test conformance to graphics standards.

A Test Requirements document describes the features and functions defined in a particular standard to which an implementation under test (IUT) shall be tested for conformance. It is vital to the correctness and completeness of a test suite that the Test Requirements document be developed in parallel with the standard. This guarantees communication between the standards developers and test suite developers, which ensures that features in the standard are defined in a manner which makes testing possible. It also ensures that the tests are more comprehensive because the test developers are directly involved in the specification of the standards and can more thoroughly understand what needs to be tested.

4.2 Graphics conformance testing

Generally, the semantics for standards are specified using the English language in narrative form. As suitable formal specification techniques mature and experience in their usage grows, it is desirable that the semantics of standards be specified using such techniques. This would reduce the probability of errors and ambiguities in the standard. Additionally, if formal specifications existed, formal proofs of correctness could be developed which prove conformance to the standard. This is contrasted with falsification testing which can only indicate non-conformance to the standard.