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Part 8: Model-based testing

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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/IEC documents should be noted. This document was drafted in accordance with the rules given in the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*, in cooperation with the Systems and Software Engineering Standards Committee of the IEEE Computer Society, under the Partner Standards Development Organization cooperation agreement between ISO and IEEE.

A list of all parts in the ISO/IEC/IEEE 29119 series can be found on the ISO and IEC websites.

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 and www.iec.ch/national-committees.

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Introduction

The purpose of the ISO/IEC/IEEE 29119 series is to define an internationally agreed set of standards for software testing that can be used by any organization when performing any form of software testing and using any life cycle. This document explains how the ISO/IEC/IEEE 29119 series can be adopted to support model-based testing (MBT).

Models can form an abstract or a complete description of a system from a particular perspective, for example, software behaviour and design. Software testers can use this document to understand how models of expected behaviour can be used in test design and implementation to derive test cases, including test inputs and expected results.

The concepts relating to software testing defined in ISO/IEC/IEEE 29119-1 are also applicable to this document.

The test process model on which MBT is based is defined in ISO/IEC/IEEE 29119-2. It comprises test process descriptions that define the software testing processes at the organizational level, test management level and dynamic test level. Supporting diagrams describing the processes are also provided in ISO/IEC/IEEE 29119-2. The processes defined in ISO/IEC/IEEE 29119-2 are extended to support MBT.

The templates and examples of test documentation defined in ISO/IEC/IEEE 29119-3 also apply to this document.

Software test design techniques that can be used during test design are defined in ISO/IEC/IEEE 29119-4. Each test design technique defines a test model with syntax, semantics of the model and the way to derive the test case from the test model in ISO/IEC/IEEE 29119-4. MBT models and the associated MBT tools can be used to produce a test case that, in part or as a whole, satisfies the test techniques of ISO/IEC/IEEE 29119-4.

ISO/IEC/IEEE 29119-5 addresses using keywords to support testing. A MBT approach can generate keyword test cases as defined in ISO/IEC/IEEE 29119-5.

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Software and systems engineering — Software testing —

Part 8: Model-based testing

1 Scope

This document provides requirements and guidelines on applying model-based testing (MBT) following the test processes defined in ISO/IEC/IEEE 29119-2. This document covers the following areas:

a) definitions for MBT;

b) implementing ISO/IEC/IEEE 29119-2 for MBT;

c) implementing ISO/IEC/IEEE 29119-3 for MBT.

Using MBT, the generation of a test case is systemized and automated. This document assumes that test execution is also automated. The implementation of the generation algorithm is tool-dependent and, therefore, is outside the scope of this document. MBT tool selection is also outside the scope of this document.

The test models and the information generated by the supporting MBT tools can be used, in part or whole, to satisfy the documentation requirements of ISO/IEC/IEEE 29119-3. Many MBT tools implement one or more test techniques and associated measures defined in ISO/IEC/IEEE 29119-4. These techniques are associated with individual tool implementation and are outside the scope of this document.

This document applies to MBT in all development lifecycle models.

2 Normative references

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

ISO/IEC/IEEE 29119-2, *Software and systems engineering — Software testing — Part 2: Test processes*

ISO/IEC/IEEE 29119-3, *Software and systems engineering — Software testing — Part 3: Test documentation*

ISO/IEC/IEEE 29119-4, *Software and systems engineering — Software testing — Part 4: Test techniques*

3 Terms and definitions

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

ISO, IEC and IEEE 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 https://www.electropedia.org/

— IEEE Standards Dictionary Online: available at https://ieeexplore.ieee.org/xpls/dictionary.jsp

NOTE For additional terms and definitions in the field of systems and software engineering, see ISO/IEC/IEEE 24765[3], which is published periodically as a snapshot of the SEVOCAB (Systems and software engineering vocabulary) database and is publicly accessible at https://www.computer.org/sevocab.

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3.1 Defined terms

3.1.1
actual results
set of behaviours or conditions of a *test item* (3.1.25), or set of conditions of associated data or the *test environment* (3.1.23), observed as a result of *test execution* (3.1.24)

EXAMPLE Outputs to screen, outputs to hardware, changes to data, reports and communication messages sent.

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.1]

3.1.2
expected results
observable predicted behaviour of the *test item* (3.1.25) under specified conditions based on its specification or another source

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.4]

3.1.3
formal language-based testing
formal testing
testing (3.1.32) based on the integrated use of two or more formal languages

EXAMPLE Integrated use of a formal specification and a programming language for *test case* (3.1.19) generation.

3.1.4
formal MBT
MBT (3.1.10), in which the models are represented in a *formal specification language* (3.1.5)

3.1.5
formal specification language
precise, mathematically based language used to describe the behaviour and requirements of a system

EXAMPLE B, VDM, Z[1].

3.1.6
generation parameters
test selection criteria
parameters used by an *MBT tool* (3.1.9) to control the generation of *test cases* (3.1.19)

3.1.7
MBT model
test model (3.1.27) used in *MBT* (3.1.10)

3.1.8
MBT test environment
test environment (3.1.23) that includes *MBT tools* (3.1.9)

3.1.9
MBT tool
software tool used to support *MBT* (3.1.10) activities

EXAMPLE 1 A software tool that supports modelling can be used for MBT model creation.

EXAMPLE 2 A software tool that supports *test case* (3.1.19) generation from the MBT model.

3.1.10
model-based testing
MBT
model-driven testing
MDT
methodology to automatically generate and execute *test cases* (3.1.19) from models of expected behaviour

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3.1.11
model element
identifiable part of a model

EXAMPLE A single state in a state diagram.

3.1.12
model fidelity
degree to which the *MBT* (3.1.10) model matches the precondition, the input and the expected behaviour of the *test item* (3.1.25)

3.1.13
modelling language
notations and structures to describe models that have an explicit definition of the syntax

Note 1 to entry: Some modelling languages also have a definition of semantics.

3.1.14
offline MBT mode
MBT (3.1.10) approach in which *test cases* (3.1.19) are generated and stored in a repository or the *MBT tool* (3.1.9) for execution later

3.1.15
online MBT mode
MBT (3.1.10) approach in which *test cases* (3.1.19) are created and immediately executed before the next test case is generated

3.1.16
performance testing
type of *testing* (3.1.32) conducted to evaluate the degree to which a *test item* (3.1.25) accomplishes its designated functions within given constraints of time and other resources

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.11]

3.1.17
security testing
test type (3.1.30) conducted to evaluate the degree to which a *test item* (3.1.25), and associated data and information, are protected so that unauthorized persons or systems cannot use, read, or modify them, and authorized persons or systems are not denied access to them

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.19]

3.1.18
test
activity in which a system or component is executed under specified conditions, the results are observed or recorded, and an evaluation is made of some aspect of the system or component

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.21]

3.1.19
test case
set of preconditions, inputs and *expected results* (3.1.2), developed to drive the execution of a *test item* (3.1.25) to meet *test objectives* (3.1.28)

Note 1 to entry: A test case is the lowest level of test implementation documentation (i.e. test cases are not made up of test cases) for the *test level* (3.1.26) or *test type* (3.1.30) for which it is intended.

Note 2 to entry: Test case preconditions include the required state of the *test environment* (3.1.23), data (e.g. databases) used by the test item, and the test item itself.

Note 3 to entry: Inputs are the data information and actions, where applicable, used to drive *test execution* (3.1.24).

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.23]

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3.1.20
test condition
testable aspect of a component or system, such as a function, transaction, feature, quality attribute, or structural element identified as a basis for *testing* (3.1.32)

Note 1 to entry: The ISO/IEC/IEEE 29119 series does not use the concept of test conditions but instead uses the concept of a *test model* (3.1.27) for test design.

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.27]

3.1.21
test coverage
degree, expressed as a percentage, to which specified *test coverage items* (3.1.22) have been exercised by a *test case* (3.1.19) or test cases

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.28]

3.1.22
test coverage item
measurable attribute of a *test item* (3.1.25) that is the focus of *testing* (3.1.32)

EXAMPLE Equivalence partitions, transitions between states, executable statements.

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.29, modified — The admitted term "coverage item" has been removed.]

3.1.23
test environment
environment containing facilities, hardware, software, firmware, and procedures needed to conduct a *test* (3.1.18)

Note 1 to entry: A test environment can contain multiple environments to accommodate specific *test levels* (3.1.26) or types (e.g. a unit test environment, a performance test environment).

Note 2 to entry: A test environment can comprise several interconnected systems or virtual environments.

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.34]

3.1.24
test execution
process of running a *test* (3.1.18) on the *test item* (3.1.25), producing *actual results* (3.1.1)

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.38]

3.1.25
test item
test object
work product to be tested

EXAMPLE Software component, system, requirements document, design specification, user guide.

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.42]

3.1.26
test level
one of a sequence of *test* stages, each of which is typically associated with the achievement of particular objectives and used to treat particular risks

EXAMPLE The following are common test levels, listed sequentially: unit/component *testing* (3.1.32), integration testing, system testing, system integration testing, and acceptance testing.

Note 1 to entry: It is not always necessary for a *test item* (3.1.25) to be tested at all test levels, but the sequence of test levels generally stays the same.

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Note 2 to entry: Typical objectives can include consideration of basic functionality for unit/component testing, interaction between integrated components for integration testing, acceptability to end users for acceptance testing

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.43]

3.1.27
test model
representation of the *test item* (3.1.25), which allows the *testing* (3.1.32) to be focused on particular characteristics or qualities

EXAMPLE Requirements statements, equivalence partitions, state transition diagram, use case description, decision table, input syntax, source code, control flow graph, parameters and values, classification tree, natural language.

Note 1 to entry: The test model and the required *test coverage* (3.1.21) are used to identify *test coverage items* (3.1.22).

Note 2 to entry: A separate test model can be required for each type of required test coverage included in the test completion criteria.

Note 3 to entry: A test model can include one or more *test conditions* (3.1.20).

Note 4 to entry: Test models are commonly used to support test design (e.g. they are used to support test design in ISO/IEC/IEEE 29119-4, and they are used in *model-based testing* (3.1.10). Other types of models exist to support other aspects of testing, such as *test environment* (3.1.23) models, test maturity models and test architecture models.

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.46]

3.1.28
test objective
reason for performing *testing* (3.1.32)

EXAMPLE Checking for correct implementation, identification of defects, measuring quality.

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.49]

3.1.29
test oracle
source of information for determining whether a *test* (3.1.18) has passed or failed

Note 1 to entry: The test oracle is often a specification used to generate *expected results* (3.1.2) for individual *test cases* (3.1.19), but other sources may be used, such as comparing *actual results* (3.1.1) with those of another similar program or system or asking a human expert.

[SOURCE: ISO/IEC/IEEE 29119-1:2022, 3.115]

3.1.30
test type
testing (3.1.32) that is focused on specific quality characteristics

EXAMPLE *Security testing* (3.1.17), functional testing, usability testing, and *performance testing* (3.1.16).

Note 1 to entry: A test type can be performed at a single *test level* (3.1.26) or across several test levels (e.g., performance testing performed at unit and system test levels).

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.60]

3.1.31
testware
artefacts produced during the *test* (3.1.18) process required to plan, design, and execute tests

Note 1 to entry: Testware can include such things as documentation, scripts, inputs, *expected results* (3.1.2), files, databases, environment, and any additional software or utilities used in the course of *testing* (3.1.32).

[SOURCE: ISO/IEC/IEEE 29119-1:2022, 3.132]

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3.1.32
testing
set of activities conducted to facilitate the discovery and/or evaluation of properties of one or more *test items* (3.1.25)

Note 1 to entry: Testing activities include planning, preparation, execution, reporting, and management activities insofar as they are directed towards testing.

[SOURCE: ISO/IEC/IEEE 29119-2:2021, 3.61]

3.1.33
traceability information
records of the relationship between products of the development and *test* (3.1.18) process

Note 1 to entry: Products of the development and test process include requirements, quality attributes, *MBT models* (3.1.7) and *test cases* (3.1.19).

3.2 Abbreviated terms

BNF	Backus-Naur form
BPMN	Business Process Model and Notation
CI	Continuous Integration
CT	Continuous Test
ESS	Employee Self-Service Users
FPGA	Field Programmable Gate Array
GUI	Graphical User Interface
HRM	Human Resource Management
MBT	Model-Based Testing
MCDC	Modified Condition Decision Coverage
MDT	Model-Driven Testing
OSLC	Open Service for Lifecycle Collaboration
TMS	Test Management System
UML	Unified Modelling Language
Z	Z formal specification notation

4 Conformance

4.1 Intended usage

The requirements in this document are contained in Clause 6, Clause 7 and Clause 8.

This document provides requirements and recommendations for MBT. It is recognized that particular projects or organizations may not need to use all the activities or tasks described in this document. Therefore, implementation of this document typically involves selecting a set of activities suitable for the organization or project.

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