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TECHNICAL REPORT

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Reference

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Keywords

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Methods for Testing and Specification (MTS).

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The present document is complementary to the multi-part deliverable covering the Test Description Language as identified below:

ETSI ES 203 119-1:	"Abstract Syntax and Associated Semantics";
ETSI ES 203 119-2:	"Graphical Syntax";
ETSI ES 203 119-3:	"Exchange Format";
ETSI ES 203 119-4:	"Structured Test Objective Specification (Extension)".

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1 Scope

The present document summarizes technical aspects related to the reference implementation of TDL. It describes both the implementation details needed for further development and integration of the tools as well as gives usage instructions for end users.

Following tools and components are covered in the present document:

- implementation of the TDL meta-model;
- viewer for the graphical representation format of TDL;
- various TDL model editors;
- facilities for checking the semantic validity of models according to the constraints specified in the TDL meta-model;
- implementation of the UML profile for TDL; and
- editor supporting the creation and manipulation of UML models applying the UML profile for TDL.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Eclipse Foundation^{TM}: Eclipse IDE Website (last visited 30.03.2016).

NOTE: Available at https://eclipse.org.

[i.2] Eclipse Foundation^{TM}: Eclipse Xtext^{TM} Website (last visited 30.03.2016).

NOTE: Available at https://eclipse.org/Xtext/index.html.

[i.3] Eclipse Foundation^{TM}: Eclipse Sirius^{TM} Website (last visited 30.03.2016).

NOTE: Available at http://www.eclipse.org/sirius/index.html.

[i.4] Eclipse Foundation^{TM}: Eclipse Modeling Framework (EMF^{TM}) Website (last visited 30.03.2016).

NOTE: Available at http://www.eclipse.org/modeling/emf/.

[i.5] Eclipse Foundation^{TM}: Eclipse Papyrus^{TM} Modeling Environment Website (last visited 30.03.2016).

NOTE: Available at https://www.eclipse.org/papyrus/.

[i.6] Eclipse Foundation^{TM}: UML^{TM} Profiles Repository Website (last visited 30.03.2016).

NOTE: Available at https://projects.eclipse.org/projects/modeling.upr.

[i.7] Eclipse Foundation^{TM}: Graphical Modeling Framework (GMF^{TM}) Website (last visited 30.03.2016).

NOTE: Available at http://www.eclipse.org/modeling/gmp/.

[i.8] "Object Constraint LanguageTM (OMG® OCL^{TM}), Version 2.4", formal/2014-02-03.

NOTE: Available at http://www.omg.org/spec/OCL/2.4/.

[i.9] Eclipse Foundation^{TM}: Eclipse OCL^{TM} Website (last visited 30.03.2016).

NOTE: Available at https://projects.eclipse.org/projects/modeling.mdt.ocl.

[i.10] Plutext Pty Ltd: Docx4j Website (last visited 30.03.2016).

NOTE: Available at http://www.docx4java.org/trac/docx4j.

[i.11] "OMG® XML^{TM} Metadata Interchange (XMI^{TM}) Specification", Version 2.4.2, formal/ 2014-04-04.

NOTE: Available at http://www.omg.org/spec/MOF/2.4.2/.

[i.12] Eclipse Foundation^{TM}: Epsilon^{TM} Validation Language (EVL^{TM}) Website (last visited 30.03.2016).

NOTE: Available at http://www.eclipse.org/epsilon/doc/evl/.

[i.13] ETSI ES 203 119-1 (V1.3.1): "Methods for Testing and Specification (MTS); The Test Description Language (TDL); Part 1: Abstract Syntax and Associated Semantics".

[i.14] ETSI ES 203 119-2 (V1.2.1): "Methods for Testing and Specification (MTS); The Test Description Language (TDL); Part 2: Graphical Syntax".

[i.15] ETSI ES 203 119-3 (V1.2.1): "Methods for Testing and Specification (MTS); The Test Description Language (TDL); Part 3: Exchange Format".

[i.16] ETSI ES 203 119-4 (V1.2.1): "Methods for Testing and Specification (MTS); The Test Description Language (TDL); Part 4: Structured Test Objective Specification (Extension)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

abstract syntax: graph structure representing a TDL specification in an independent form of any particular encoding

concrete syntax: particular representation of a TDL specification, encoded in a textual, graphical, tabular or any other format suitable for the users of this language

meta-model: modelling elements representing the abstract syntax of a language

system under test (SUT): role of a component within a test configuration whose behaviour is validated when executing a test description

TDL model: instance of the TDL meta-model

TDL specification: representation of a TDL model given in a concrete syntax

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

API	Application Programming Interface
EBNF	Extended Backus-Naur Form
EMF	Eclipse Modelling Framework
EVL	Epsilon Validation Language
GMF	Graphical Modelling Framework
MBT	Model-Based Testing
MOF	Meta-Object Facility
OCL	Object Constraint Language
OMG	Object Management Group®
SUT	System Under Test
TDL	Test Description Language
UML	Unified Modelling Language
URI	Unified Resource Identifier
XMI	XML Metadata Interchange
XML	eXtensible Markup Language

4 Basic Principles

4.1 Introduction

To accelerate the adoption of TDL, a reference implementation of TDL is provided in order to lower the barrier to entry for both users and tool vendors in getting started with using TDL. The reference implementation comprises graphical and textual editors, as well as validation facilities. In addition, the UML profile for TDL and supporting editing facilities are implemented in order to enable application of TDL in UML-based working environments and model-based testing approaches.

4.2 Implementation Scope

The implementation scope includes a graphical viewer according to ETSI ES 203 119-2 [i.14] based on the Eclipse platform [i.1] and related technologies, covering essential constructs related to test configurations and test behaviour specification. For creating and manipulating models, a textual editor for ETSI ES 203 119-1 [i.13], annex B is implemented based on the Eclipse platform and related technologies. The applicability of general purpose model editing facilities provided by the Eclipse platform and related technologies is discussed.

For tools that need to import and export TDL models according to ETSI ES 203 119-3 [i.15], corresponding facilities are implemented based on the Eclipse platform and related technologies. These facilities can be used to transform textual representations based on ETSI ES 203 119-1 [i.13] into XMI [i.11] serializations according to ETSI ES 203 119-3 [i.15] and can be integrated in custom tooling that builds on the Eclipse platform.

An implementation of ETSI ES 203 119-4 [i.16] includes a dedicated textual editor for structured test objectives, which can be integrated in the textual editor for TDL. The implementation also includes facilities for exporting structured test objectives to Word documents using customisable tabular templates.

An implementation of the UML profile for TDL includes a specification of the TDL UML profile abstract syntax according to the mapping from the TDL meta-model to TDL stereotypes and UML meta-classes in ETSI ES 203 119-1 [i.13], annex C. It is integrated with the open source UML modelling environment Eclipse Papyrus [i.5] as an open TDL UML profile reference implementation platform. It will be published on the open source "Eclipse UML Profiles Repository" project [i.6].

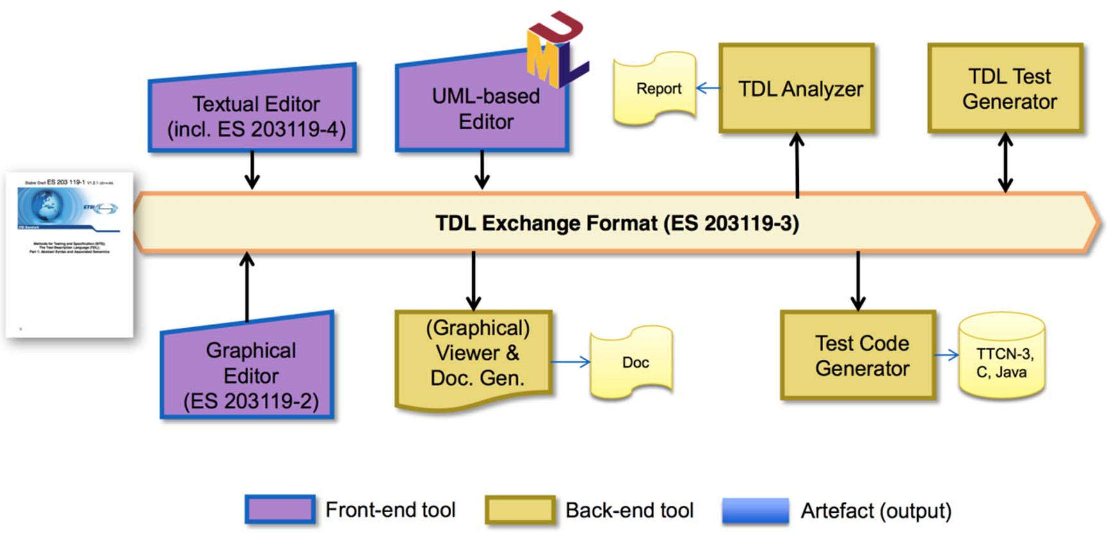


Figure 4.2.1: TDL tool infrastructure

An overview of the context of the reference implementation is shown in Figure 4.2.1. The TDL exchange format specified in ETSI ES 203 119-3 [i.15] serves as a bridge between the different tool components. Textual editors enable the creation and manipulation of TDL models. The graphical viewer is used to visualize TDL models as diagrams. Documentation generation, in particular for structured test objectives, can be plugged in to produce Word documents for presenting parts of a TDL model in a format suitable for standardization documents.

The complete implementation will be published on an open-source portal serving as a central hub for the TDL community.

4.3 Document Structure

The present document contains two main technical clauses focusing on relevant technical details. The Graphical Representation Viewer implementing ETSI ES 203 119-2 [i.14], as well as related facilities implementing ETSI ES 203 119-1 [i.13], ETSI ES 203 119-3 [i.15] and ETSI ES 203 119-4 [i.16] are described in clause 5. The UML Profile Editor implementing annex C of ETSI ES 203 119-1 [i.13] is described in clause 6.

5 Graphical Representation Viewer

5.1 Scope and Requirements

TDL graphical viewer implementation has two major requirements. The main objective is to provide means to visualize TDL models according to the graphical notation. The second objective is to facilitate layout of diagrams in a way that is suitable for documentation. For the second purpose, it is essential to provide graphical editing capabilities. Although often provided by modelling frameworks, the ability to graphically edit the underlying models (that is, to create new elements and set their properties) is not considered relevant for this implementation.

Eclipse provides several graphical modelling tools to help build editors. Sirius [i.3] was chosen for its declarative approach that provides separation between meta-model mappings and implementations of graphical elements. With the existence of predefined common graphical elements such as containers and connectors, the effort of implementing graphical editor with custom syntax in Sirius is only spent on the parts that diverge from those common elements.

Another area that requires custom implementation is the layout of graphical elements. This covers both the absolute placement of nodes on the diagram as well as the size and internal contents of each node. Due to rather hierarchical nature of the TDL graphical syntax, several additional base graphical elements are introduced. Some peculiar limitations of Sirius have also been identified prior to the implementation, which also need appropriate workarounds. The goal of implementing diagram layout is to automate diagram creation to the extent that the sizes and contents of graphical elements are adjusted by layout algorithms while the absolute placement of diagram elements is solved by using built in layout implementations. This will guarantee minimal user interaction with diagram editor for achieving desired layouts.

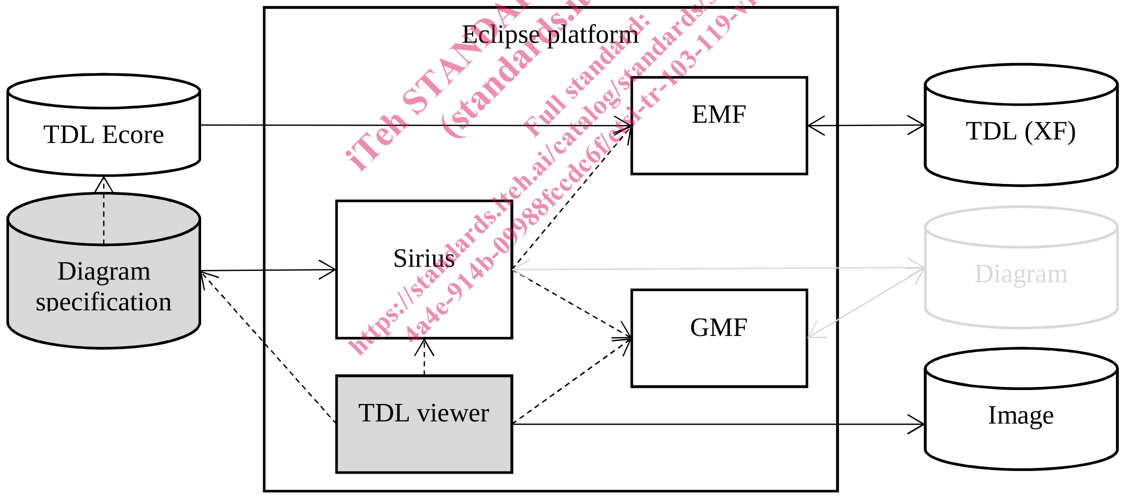
Diagram export for documentation purposes is provided by the framework. The viewer implementation will add complimentary export to Word document format.

Due to the peculiarities and intended use of structured test objectives, it was determined that instead of graphical shapes that can be exported as images, the graphical representation are realized as tables exported in a Word document according to user-defined templates. These tables can then be manipulated further as necessary to fit in within an existing document.

5.2 Architecture and Technology Foundation

5.2.1 Diagram Viewer

TDL viewer is built on Eclipse platform to benefit from its wide range of modelling tools. The main Eclipse projects that are used as basis for this implementation are shown in Figure 5.2.1. Sirius is a technology that allows declarative creation of graphical editors that work with EMF models. It uses GMF [i.7] to create visual diagram elements and link those to model objects. Model management and serialization is done by EMF [i.4].



NOTE: Components with grey background are part of the implementation that is covered by the present document.

Figure 5.2.1: Dependencies and data flows of TDL viewer

Every EMF model is based on a meta-model that is defined in terms of meta-modelling system named Ecore. TDL meta-model in UML format was converted to Ecore meta-model (TDL Ecore) using Papyrus UML and EMF facilities. Furthermore, Java code for the TDL meta-model was generated based on the TDL meta-model.

Sirius creates diagram editors by interpreting diagram specification files. These files contain TDL meta-model references in the form of Java or OCL [i.8] queries. OCL support is provided by the Eclipse OCL project [i.9], Java queries are references to classes that are part of the TDL viewer source code. Diagram specifications also contain definitions of Sirius specific styles that are applied to model objects when rendering them on diagrams. Since the TDL viewer requires customized shapes, it has dependencies on both the Sirius API and the Eclipse GMF. Several extensions to GMF classes have been implemented in Sirius in order to configure shapes according to the customized styles. GMF facilities are then used to export diagrams as images.

Some of the labels in the graphical shapes, in particular labels related to data specification and data use have a complex structure. For their realization, facilities provided by Xtext [i.2] are used to serialize model fragments related to data use as text according to an annotated EBNF grammar derived from the formal label specifications in ETSI ES 203 119-2 [i.14].

5.2.2 Structured Test Objective Representation

Structured test objectives are exported as tables in a Word document according to user-defined templates. The export relies on facilities provided by Xtext as well as the Docx4j library [i.10] providing API for manipulating Word documents. The exporting facilities take a Word document containing one or more templates in the form of tables with placeholders and a TDL model containing one or more structured test objectives as input. The user has to provide the name of the desired template as an additional input. For every structured test objective, the selected template is copied into a new empty document and the placeholders are replaced by the content serialized from the corresponding TDL element according to the Xtext mappings in a similar manner as the labels for the diagram viewer. The representation process is sketched on Figure 5.2.2. The generated tables in the new Word document can be further manipulated or merged into an existing document containing additional information. Additional templates may be defined by users to suit specific needs.

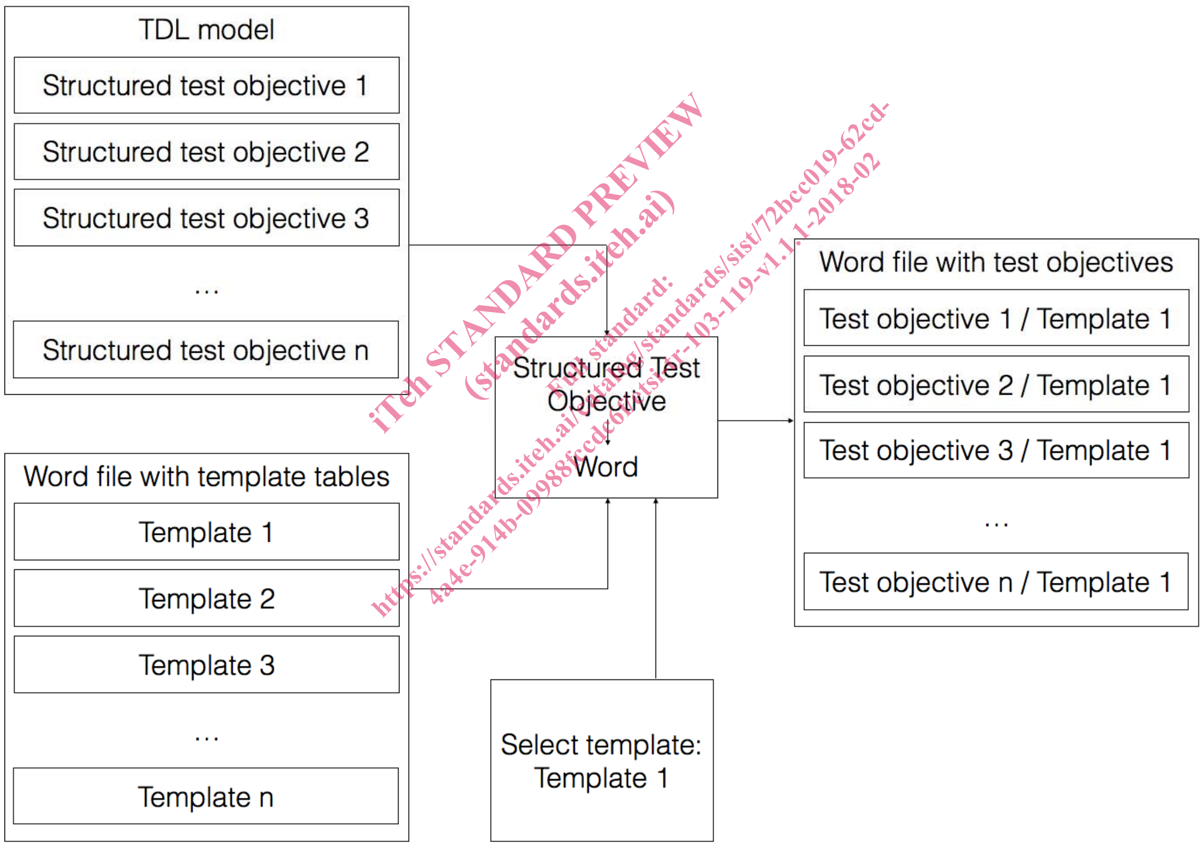

TDL model
Structured test objective 1
Structured test objective 2
Structured test objective 3
…
Structured test objective n
Word file with template tables
Template 1
Template 2
Template 3
…
Template n
Structured Test Objective
Word
Select template: Template 1
Word file with test objectives
Test objective 1 / Template 1
Test objective 2 / Template 1
Test objective 3 / Template 1
…
Test objective n / Template 1

Figure 5.2.2: Structured test objective representation process

5.3 Implemented Facilities

5.3.1 Creating Models

Overview

Model instances are the primary artefacts for TDL. They carry the semantic information. In a modelling environment there are various means for creating, viewing, and manipulating model instances of a particular meta-model. Comprehensive modelling environments typically provide generic model facilities that enable working with model instances of arbitrary meta-models, provided the meta-model is known. Generic model facilities provide sufficient capabilities for performing basic tasks on model instances. However, due to their generic nature, they are cumbersome to work with, lack of support for certain features that are not expressed in the meta-model directly (unless customized), and do not provide domain-specific features such as syntactical customization beyond basic adaptations.

Custom syntax implementations address some of the shortcomings of generic model editors. Such implementations enable the specification of a customized representation of a model instance in a format that is tailored to a specific group of users. There may be multiple custom syntax implementations mapped to the same meta-model, serving different stakeholders or even different purposes for the same stakeholder. Custom syntax implementations may cover only a subset of the meta-model, restricting the access to certain features that are not relevant for specific stakeholders or purposes. Modelling environments provide platforms for the realization of custom syntax implementations. Custom syntax implementations may rely on secondary artefacts that store the concrete representation of the TDL model instance.

TDL model instances may be produced automatically by tools. The exchange format for TDL enables the interoperability of tools producing model instances and tools for manipulating model instances.

Generic Model Editors

The EMF provides facilities for generating basic tree editors for a given meta-model, which can then be customized to an extent while still remaining within the tree editor paradigm. In addition, the EMF also provides generic reflective model editors which provide quick access to model instances of any meta-model. An example of such an editor for TDL is shown in Figure 5.3.1. The example includes a tree-based editor for manipulating the overall structure of a model on top and a detailed property view for manipulating individual properties on the bottom.

Extensions to the EMF such as MoDisco include additional generic facilities such as the MoDisco model browser which provides faceted browsing and editing of model instances. Faceted browsing provides filtering by type, as well as deep navigation across references. In addition, MoDisco also includes tabular views on different parts of the model for a quick overview across multiple dimensions. An example for a TDL model is illustrated in Figure 5.3.2. The example includes a faceted browser on the top for navigating and manipulating the overall structure of a model, as well as individual properties of model elements. On the left side of the faceted browser, model elements can be filtered by type. Below the faceted browser, a tabular viewer provides more compact representation of multiple model elements at the same level in a model tree, such as the behaviour elements of a block. The property view on the bottom part of the example still allows the manipulation of properties of selected model elements.