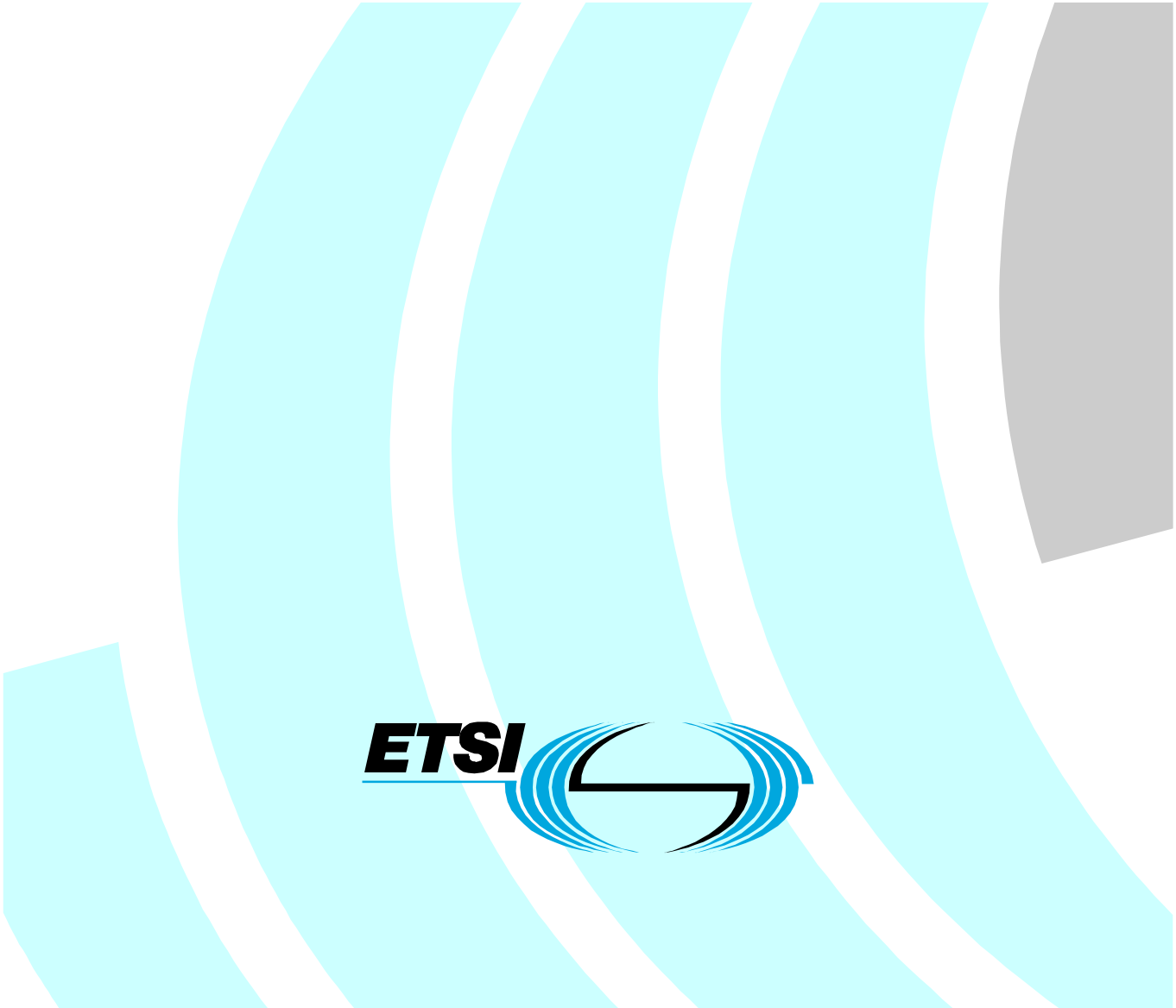
ETSI TR 102 205 V1.1.1 (2003-05)

Technical Report

Methods for Testing and Specification (MTS); UML 2.0 action syntax feasibility study



Reference
DTR/MTS-00084

Keywords
UML, MTS

ETSI

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Foreword

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

1 Scope

The present document is a study on the feasibility of defining an action syntax for UML 2.0 for possible use in standardization. In addition, the need for an action semantics is discussed as well as what needs to be done in order to define a UML profile.

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ITU-T Recommendation Z.100: "Specification and Description Language (SDL)".

[2] ITU-T Recommendation Z.120: "Message Sequence Chart (MSC)".

[3] OMG: "United Modeling Language UML 1.5".

[4] OMG: "United Modeling Language UML 2.0; Infrastructure; ad/00-09-01 and Superstructure; ad/00-09-02".

[5] ITU-T Recommendation Z.109: "SDL Combined with UML".

[6] ETSI EG 201 872: "Methods for Testing and Specification (MTS); Methodological approach to the use of object-orientation in the standards making process".

3 Definitions and abbreviations

3.1 Definitions

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

action syntax: concrete textual or graphical language constructs needed to specify detailed behaviour

EXAMPLE: the graphical symbol to indicate the setting of a timer, the textual statement to perform an assignment, etc.

action semantics: actual meaning and definition of actions

EXAMPLE: how a message is handled when it is sent and how execution may (or may not) continue directly afterwards, in what order (and how) assignment expressions are evaluated dynamically.

UML profile: extension mechanism provided by UML

EXAMPLE: With a profile it is possible to add language constructs, to restrict existing language constructs and to define special semantics for language constructs.

3.2 Abbreviations

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

ASN.1	Abstract Syntax Notation 1
MSC	Message Sequence Charts
OCL	Object Constraint Language
OMG	Object Management Group.

NOTE: Standard body recommending UML, CORBA, IDL, etc.

SDL	Specification and Description Language
UML	Unified Modeling Language

4 Background

SDL [1] and MSC [2] are used frequently today for standard specification, both in ETSI and in other organizations. The use of UML in standardization is increasing. ETSI MTS has contributed with a guide (EG 201 872 [6]) which presents a process for using UML in the standards-making process.

4.1 UML - pros and cons

Feasibility for communication standards.

UML [3] has up to now not been a real competitor to SDL for the use of describing standard specifications. The latest UML recommendation (UML 1.5 [4]) still lacks precision and formality compared to SDL. SDL also has a longer history in the communications industry, which has affected the graphical syntax of the language that is more targeted towards the needs for protocol specification, for example.

The lack of precision of UML is currently changing, as UML is currently being revised. The forthcoming UML 2.0 [4] will:

- have a more well-defined semantics; and
- have better means for customizing, restricting and extending the language in so-called *profiles*.

Richness of UML.

UML is a graphical modeling language that is well-known for its applicability in many different application areas and purposes:

- UML has a wide set of different diagram notations that can be used in isolation or as part of a complete model;
- UML offers diagram notations that are well-suited for process modeling and requirements modeling (use cases).

UML knowledge.

UML is a widely used and accepted language. This is a major difference, compared to SDL and MSC, which are mostly known and used in parts of the real-time software industry (especially the communication industry).

4.2 Tools availability

The market for SDL and MSC tools has increased rapidly the last decade. However, the number of tool providers has decreased significantly during the same period. One cause may be that several non-commercial and in-house tools have been put to sleep either because there is not the same amount of SDL-related research at universities today or because the high cost of maintaining these tools. Another reason can be that UML is perceived as a more attractive and less specialized language compared to SDL and thus offers a wider market for tool vendors.

Another issue is that SDL tool vendors may gradually shift their focus to UML, as the language is continually improving.

4.3 SDL investments

ETSI (as well as other standardization organizations) has made large investments in SDL:

- investments in SDL-based tools;
- investments in SDL and MSC language and methodology knowledge and tool experience;
- investments in standards that have SDL and MSC specifications as normative (and non-normative) parts of the standard; which often also needs to be maintained for a number of years ahead.

5 What is wanted from UML?

When looking at what is wanted from UML, the perspective will differ depending on:

- application domain, i.e. telecom development, protocol development, etc;
- process-dependent usage, i.e. standard specification, requirements analysis, design, etc.

People used to SDL and MSC may also favour certain constructs, abstractions and semantics from those languages.

In order to be able to narrow down all possibilities, this report will focus on UML usage:

1) that is feasible for describing communication systems in particular;
2) that is feasible for standard specification of protocols in particular.

5.1 UML for describing communication systems

When looking at language features that are needed or wanted for the description of communication systems, it is natural to compare with SDL, because of its 25-year track record within that industry.

UML 2 will include several of the relevant features that exist in SDL, including:

- diagrams and constructs to specify distribution and component architecture in a detailed way, as well as the detailed communication structure;
- ready-to-use abstractions for signal sending and receiving, etc.

The following is a list of wanted features that are lacking in UML 2:

- using ASN.1 models for signal data;
- a set of predefined data types with operators for convenience;
- timers and timer handling;
- a textual action syntax;
- graphical symbols for common actions, e.g. operation call, object creation, timer set and reset, etc;
- detailed action semantics.

Note that this list only includes a few examples and is not a complete list.

5.2 UML for standard specification

When it comes to the specific use of UML for making a standard specification, most of the wanted and needed constructs will be the same as the ones identified in the previous clause. There are, however, a number of additional features that may be wanted:

- concepts to avoid over-specification, e.g. ANY, under-specified message parameters, informal decision, task and operation;
- concepts to support the description of variant systems; e.g. transition option, select.

For standard specification usage, it may also be preferred to restrict the language (compared to the complete UML or compared to "UML for communicating systems") in order to avoid that specifications are made unnecessarily complex and detailed. Limitations might, for example, include:

- use of exceptions;
- use of shared variable data between distributed components;
- no redefined transitions in specialized active classes;
- a subset of the diagram notations, etc.

Note that these restrictions would only apply to UML models used as the "end product" (the standard specification) of a communications standard, i.e. not when UML is used in the process of producing the standard specification.

It is also especially important for specifications that the UML model is intuitive and that the graphical features of the language are utilized to their full potential. This will probably best be ensured by language guidelines, similar to the SDL and MSC guidelines that ETSI has produced.

6 Action syntax in UML

UML 2 includes a number of actions, including:

- composite action;
- read and write actions;
- computation actions (e.g. mathematical functions);
- collection actions (actions on multiple objects):
  - iteration actions;
  - conditional actions;
- asynchronous request (send) and synchronous request (call);

- jump action;
- new and delete actions.

For communication systems, a number of additional actions can be identified.

The built-in, as well as the additional actions need to have a concrete textual syntax and where applicable also a corresponding graphical symbol.

The textual syntax is needed in order to guarantee portability of models as well as tool independency. The additional graphical syntax is needed in order to make sure that specification models are kept readable and intuitive.

7 Action semantics in UML

If full portability of models in terms of also supporting a detailed interpretation of the execution of models is wanted, then further additions to UML are needed, namely to detail the action semantics. This is the most complicated part of making a UML profile and requires some detailed knowledge about the UML semantics.

The following should be done:

- specify a detailed action semantics for built-in UML actions that is valid for distributed systems;
- specify action semantics for additional actions;
- make sure that existing UML semantics does not conflict with the proposed action semantics;
- make sure that the semantics of UML constructs in different diagrams are sufficiently well tied together (e.g. signal handling in active classes versus message events in sequence diagrams);
- optionally provide an operational semantics for the concepts described as part of the profile.

8 UML profile

UML includes extensibility mechanisms for extending or limiting the language itself. These modifications to standard UML are defined in a way that makes them portable between different UML tools. The previously discussed extensions and limitations to UML are thus best specified by the UML profiling mechanism.

8.1 What is a UML profile?

Definition from [3]:

A profile is a stereotyped package that contains model elements that have been customized for a specific domain or purpose by extending the metamodel using stereotypes, tag definitions and constraints. A profile may specify model libraries on which it depends and the metamodel subset it extends.

Extension mechanisms in UML are:

- profiles;
- stereotypes;
- tag definitions;
- constraints.

*Profile*s are used to group stereotypes and related constructs into a cohesive unit that extends the UML metamodel.

Stereotypes, the principal extension mechanism, define virtual UML metaclasses with new metaattributes (tag definitions) and additional semantics. It is further possible to attach constraints and new textual or graphical representations for model elements to stereotypes. This means that is possible to define specific icons for language constructs.

Tag definitions define new kinds of properties that may be added to model elements. The actual properties of individual model elements are defined by *tagged values*, based on the tag definitions. A tag can be defined by a simple data type or by the characteristics of another model element.

Constraints are attached to model elements in order to refine or constrain their semantics. Constraint rules may be specified formally, using OCL.

9 Recommended action

It is recommended that ETSI takes further action in order to make sure that UML can be used effectively for standard specification, as an alternative or possibly a successor to SDL and MSC. This task includes the definition of:

a) a textual action syntax;

b) graphical syntax extensions;

c) how ASN.1 data is used in combination with UML;

d) an action semantics; and

e) other extensions and limitations.

The ultimate way to do this is by defining a UML profile.

This task should preferably be coordinated with similar activities that are emerging within Study Group 17 in ITU-T, in particular work to update the ITU-T Recommendation Z.109 profile [5]. It should furthermore be possible to use the UML profile for communicating systems as input to defining future versions of ITU-T Recommendation Z.109 [5].

Annex A:
Feasibility study on using transition system semantics for specifying semantics of UML diagrams in the context of the MTS-UML project

The entire unchanged endorsed document is contained in an Adobe Portable Document Format™ file (AnnexA.PDF contained in archive tr_102205v010101p0.zip) which accompanies the present document.

History

Document history		
V1.1.1	May 2003	Publication