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Systems and software engineering — High-level Petri nets —

Part 2: Transfer format

Ingénierie des systèmes et du logiciel — Réseaux de Petri de haut niveau —

Partie 2: Format de transfert

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Foreword

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ISO/IEC 15909-2 was prepared by Joint Technical Committe ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

ISO/IEC 15909 consists of the following parts, under the general title *Systems and software engineering – High-level Petri nets*:

— *Part 1: Concepts, definitions and graphical notation*

— *Part 2: Transfer format*

“Extensions” will form the subject of a future Part 3.

Introduction

ISO/IEC 15909 is concerned with defining a modelling language and its transfer format, known as *High-level Petri Nets*. ISO/IEC 15909-1 provides the mathematical definition of *High-level Petri Nets*, called the semantic model, the graphical form of the technique, known as *High-level Petri Net Graphs* (HLPNGs), and its mapping to the semantic model. It also introduces some common notational conventions for HLPNGs.

This part of ISO/IEC 15909 defines a transfer format for *High-level Petri Nets* in order to support the exchange of *High-level Petri Nets* among different tools. This format is called the *Petri Net Markup Language* (*PNML*). Since there are many different versions of *Petri nets* in addition to *High-level Petri Nets*, this part of ISO/IEC 15909 defines the *core concepts* of *Petri nets* along with an XML syntax, which can be used for exchanging any kind of *Petri net*. Based on this *PNML Core Model*, this part of ISO/IEC 15909 also defines the transfer syntax for the three versions of *Petri nets* that are defined in ISO/IEC 15909-1: *Place/Transition Nets*, *Symmetric Nets*[1], and *High-level Petri Nets*, where *Place/Transition Nets* and *Symmetric Nets* can be considered to be restricted versions of *High-level Petri Nets*. For *Place/Transition Nets*, this part of ISO/IEC 15909 introduces two different transfer formats: one is a format specifically tuned to *Place/Transition Nets*, the other is a format that represents *Place/Transition Nets* as a restricted version of *High-level Petri Nets* as defined in ISO/IEC 15909-1.

The basic level of conformance to this part of ISO/IEC 15909 is to the *PNML Core Model*. The other levels are according to the particular type of the *Petri net*; for *High-level Petri Nets* there are two levels of conformance: *textual conformance* ignores the exact syntax and structure of the *labels*; *structural conformance* requires that *labels* are given in the exact syntax as defined here. Since *Symmetric Nets* are designed for analysability, *textual conformance* does not make any sense for *Symmetric Nets*; therefore, there is only *structural conformance* for *Symmetric Nets*.

Note that this part of ISO/IEC 15909 introduces some concepts that are not defined in ISO/IEC 15909-1. These concepts are not related to the mathematical concepts of *Petri nets* and their semantics. They concern the graphical representation of nets and the structuring of large *Petri net* models. These concepts need to be defined, along with a transfer format for *Petri nets*, in order to ensure that the graphical appearance of a *Petri net* in different tools is similar.

This part of ISO/IEC 15909 is structured as follows: Clause 1 describes the scope, the areas of application and the intended audience of this part of ISO/IEC 15909. Clause 2 defines conformance. Clause 3 gives references that are essential for the correct interpretation of this International Standard. Clause 4 defines all terms relevant to this International Standard and includes a list of abbreviations. Clause 5 introduces the concepts of PNML using UML meta models. Clause 5.2 defines the *PNML Core Model*, which is the structure common to all versions of *Petri nets*. Clause 5.3 defines the particular concepts of the different *Petri net types*. Clause 6 provides the mapping of the syntactical concepts defined in this part of ISO/IEC 15909 to the concepts defined in ISO/IEC 15909-1. Clause 7 defines how the concepts of PNML as defined in Clause 5 are mapped to XML syntax.

Annex A defines the exact XML syntax for the *PNML Core Model* in terms of a RELAX NG grammar. Annex B defines the exact XML syntax for the different types of *Petri nets*. Annex C provides a small example for the syntax of a symmetric net. Annex D discusses a framework for implementing this International Standard and an API for accessing *Petri nets*, which is based on the UML models for the PNML meta models.

[1] Symmetric nets were first introduced as well-formed nets and are currently standardized as ISO/IEC 15909-1:2004/Amd. 1:2010.

Systems and software engineering – High-level Petri nets – Part 2: Transfer format

1 Scope

This part of ISO/IEC 15909 defines an XML-based transfer format for *Petri nets*, which are defined conceptually and mathematically in ISO/IEC 15909-1. This transfer format enables the exchange of *Petri nets* among different *Petri net* tools and among different parties. Moreover, this part of ISO/IEC 15909 defines some concepts and XML-based syntax for defining the detailed graphical appearance of *Petri nets*.

The focus of this part of ISO/IEC 15909 is on the transfer format for *Place/Transition Nets*, *High-level Petri Nets* and *Symmetric Nets*. The presentation, however, is structured in such a way that it is open for future extensions, so that other versions of *Petri nets* can be added later. The exact definition of this extension mechanism, called *Petri net type definition*, is not defined in this part of ISO/IEC 15909; it will be defined in ISO/IEC 15909-3.

The transfer format will be used to transfer specifications of systems developed in *High-level Petri Nets* between tools to facilitate the development of systems in teams.

This part of ISO/IEC 15909 is written as a reference for developers of *Petri net* tools. Moreover, it will be useful for researchers who define new versions and variants of *Petri nets*.

2 Conformance

There are different levels of conformance to this part of ISO/IEC 15909. All conformance levels impose additional conditions on valid XML documents.

2.1 PNML Documents

An XML document is conformant to the *PNML Core Model* if it meets the definitions of Clause 5.2 (concepts) and Clause 7.1 (their mapping to XML syntax) – such a document is called a *PNML Document* or a *Petri Net Document*. A Petri net tool is conformant to the *PNML Core Model* if it can import all *PNML Documents* and if it can export all *Petri nets* to a *PNML Document*.

The other levels of conformance concern the different *Petri Net Types*.

2.2 PNML Place/Transition Net Documents

A *PNML Document* is a conformant *Place/Transition Net* if it meets the additional restrictions of Clause 5.3.1 (concepts of P/T-nets) and Clause 7.2 (their mapping to XML syntax) – such a document is called a *PNML Place/Transition Net Document*. A Petri net tool is conformant to the *PNML Place/Transition Net* definition if it can import all *PNML Place/Transition Net Documents*, and if it can export all *Place/Transition Nets* to *PNML Place/Transition Net Documents*. Note that this transfer format is tuned to *Place/Transition Nets*. There is another format, which considers *Place/Transition Nets* as a restricted form of *High-level Petri Nets* (see Clause 2.5).

2.3 Textually conformant PNML High-level Petri Net Documents

For *High-level Petri Nets*, there are two different levels of conformance. The first level requires the existence of textual labels as defined in Clause 5.3.2 and 5.3.11 (concepts) and Clause 7.3 (mapping to XML syntax). But,

it does not require the existence of the structural parts of the *annotations*; it only requires that the textual parts of the *annotations* exist, but the text is not required to be in a specific syntax and, therefore, the meaning of it cannot be transferred to other tools. Such a *PNML Document* is called a *textually conformant PNML High-level Petri Net Document*. A Petri net tool is conformant to the *textual PNML High-level Petri Net* definition if it can import all *textually conformant PNML High-level Petri Net Documents*, and if it can export all *High-level Petri Nets* to a *textually conformant PNML High-level Petri Net Document*.

2.4 Structurally conformant PNML High-level Petri Net Documents

The second level of *High-level Petri Net* conformance requires that all *annotations* obey the rules defined in Clause 5.3.2 and 5.3.11 (concepts) and Clause 7.3 (mapping to XML syntax). Such a *PNML Document* is called a *structurally conformant PNML High-level Petri Net Document*. A Petri net tool is conformant to the *structural PNML High-level Petri Net* definition if it can import all *structurally conformant PNML High-level Petri Net Documents*, and if it can export all *High-level Petri Nets* to a *structurally conformant PNML High-level Petri Net Document*.

2.5 Place/Transition Net Document in High-level Notation

A *structurally conformant PNML High-level Petri Net Document* that uses only the single sort *dot* and only the *arc annotations* of *Place/Transition Nets* is a *conformant Place/Transition Net Document in High-level Notation*.

2.6 Symmetric Net Documents

Finally, there is conformance to *Symmetric Nets*, which is a restricted version of *High-level Petri Nets*. A *Symmetric Net Document* is a *structurally conformant PNML High-level Petri Net Document* if it contains only the concepts defined in Clause 5.3.10. A Petri net tool is conformant to the *Symmetric Net* definition if it can import all *Symmetric Net Documents*, and if it can export all *Symmetric Nets* to *Symmetric Net Documents*.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 15444 (all parts), *Information technology – JPEG 2000 image coding system*

ISO/IEC 15909-1, *Systems and software engineering – High-level Petri nets – Part 1: Concepts, definitions and graphical notation*

ISO/IEC 15948, *Information technology – Computer graphics and image processing – Portable Network Graphics (PNG): Functional specification*

ISO/IEC 19757-2:2008, *Information technology – Document Schema Definition Language (DSDL) – Part 2: Regular-grammar-based validation – RELAX NG*

CSS, *Cascading Style Sheets, level 2 revision 1, CSS 2.1 Specification ; W3C Candidate Recommendation, 25 February 2004*

OCL 2.0, *Object Constraint Language, OMG Available Specification, Version 2.0. OMG formal/06-05-01, May 2006*

UML 2.1, *OMG Unified Modeling Language (OMG UML): Superstructure, V2.1.2 OMG Available Specification, November 2007*

XML 1.1, *Extensible Markup Language (XML) 1.1 (Second Edition); W3C Recommendation, 29 September 2006*

XML Schema Datatypes: *XML Schema Part 2: Datatypes (Second Edition); W3C Recommendation, 28 October 2004*

