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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 15909-2 was prepared by Joint Technical Committee 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
CSS, Cascading Style Sheets, level 2 revision 1, CSS 2.1 Specification; W3C Candidate Recommendation, 25 February 2004
XML 1.1, Extensible Markup Language (XML) 1.1 (Second Edition); W3C Recommendation, 29 September 2006