ISO/IEC JTC1/SC7
Software & System Engineering
Secretariat: CANADA (SCC)

ISO/IEC JTC1/SC7 N2658

2002-06-26

Doc. Type	**NP Ballot**
Title	**New Proposal for a Standard on Petri Net Techniques**
Source	**SC7 / WG19**
Project	
Status	**NP**
References	**SC7 Resolution 667, N1441, N1494, N1947, N2003, N2634, N2635**
Action ID	**ACT**
Due Date	**2002-09-26**
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Distribution	**SC7_AG; JTC1 Sec.; P, O & L Members**
Medium	**PDF**
No. Of Pages	**15**
Note	**This ballot is also sent to JTC1 for a parallel endorsement balltot, as per new directives. Member Bodies must use the form included on the ballot and provide answers to all questions.**

Address reply to: ISO/IEC JTC1/SC7 Secretariat
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VOTE ON A PROPOSED NEW WORK ITEM ISO/IEC JTC 1/SC7 N2658

Date of Circulation of NP: **2002-06-26**

Date of Ballot Close: **2002-09-26**

Please return all votes and comments directly to the JTC 1/SC 7 Secretariat (secretariat@jtc1-sc7.org) by the due date indicated.

Proposal for a new work item on

New Proposal for a Standard on Petri Net Techniques

Any proposal to add a new item to the programme of work shall be voted on by correspondence, even if it has appeared in the agenda of a meeting.

A. Vote		**YES**	**NO**	**Comments**
Q.1	Do you accept the proposal in document JTC 1 N XXXX as a sufficient definition of the new work item? (If you have responded "NO" to the above question, you are required to comment.)	____	____	____
Q.2	Do you support the addition of the new work item to the programme of work of the joint technical committee?	____	____	____
B. Participation				
Q.3	Do you commit yourself to participate in the development of this new work item?	____	____	____
Q.4	Are you able to offer a project editor who will dedicate his/her efforts to the advancement and maintenance of this project? (If "YES," please identify .....)	____	____	____
C. Documentation				
Q.5	Do you have a major contribution or a reference document ready for submittal?	____	____	____
Q.6	Will you have such a contribution in ninety days?	____	____	____

P-member Voting:	**Date:**	**Submitted by:**
National Body		Name
_____	_____	_____

NOTE: do NOT submit this form when voting by email. Simply type your vote (with comments where applicable) into an email message and send to Secretariat@jtc1-sc7.org.

PROPOSAL FOR A NEW WORK ITEM

Date of presentation of proposal: 2002-06-26	Proposer: ISO/IEC JTC 1/SC 7 WG19
Secretariat: SCC (Canada)	ISO/IEC JTC 1 Nxxxx ISO/IEC JTC 1/SC7 N **2658**

Presentation of the proposal - to be completed by the proposer.

Title (subject to be covered and type of standard, e.g. terminology, method of test, performance requirements, etc.)

Title**: Petri Net Techniques**

Type: modelling method and notations

Scope (and field of application)

See Annex A

Purpose and justification - attach a separate page as annex, if necessary

This NWI is being proposed to reactivate Project 7.19.3, Petri Net Techniques for which ISO/IEC 15909 has been assigned.

See Annex A for further explanation.

Programme of work

If the proposed new work item is approved, which of the following document(s) is (are) expected to be developed?
____ a single International Standard more than one International Standard (expected number: .....)
__X_a multi-part International Standard consisting of three parts
____ an amendment or amendments to the following International Standard(s) .....
____ a technical report , type .....

See Annex A for further information

Relevant documents to be considered

SC7 N1441 (Subdivision of Project 7.19 for a Petri net standard)
SC7 N1494 (Subdivision ballot summary)
SC7 N1947 (FCD 15909 ballot)
SC7 N2003 (FCD 15909 ballot summary)
SC7 N2634 (FDIS 15909, revised FCD 15909 after comment resolution)
SC7 N2635 (Summary and Disposition of Comments on FCD 15909)

For a list of other relevant documents see Annex A

Cooperation and liaison

Steering Committee of the International Conference on Application and Theory of Petri Nets

Preparatory work offered with target date(s) See Annex A
Signature: WG 19
Will the service of a maintenance agency or registration authority be required? .....No..... - If yes, have you identified a potential candidate? ..... - If yes, indicate name ..... Are there any known requirements for coding? .....No..... -If yes, please specify on a separate page Are there any known requirements for cultural and linguistic adaptability? .....Yes..... - If yes, please specify on a separate page This will affect Part 2 on Transfer Format where multi-byte character sets should be considered. Does the proposed standard concern known patented items? .....No..... - If yes, please provide full information in an annex

Comments and recommendations of the JTC 1 Secretariat - attach a separate page as an annex, if necessary

Comments with respect to the proposal in general, and recommendations thereon: It is proposed to assign this new item to JTC 1/SC 7

Voting on the proposal - Each P-member of the ISO/IEC joint technical committee has an obligation to vote within the time limits laid down (normally three months after the date of circulation).

Date of circulation:	**Closing date for voting:**	**Signature of SC7 Secretary:**
2002-06-26	2002-09-26	Alain Abran

NEW WORK ITEM PROPOSAL - PROJECT ACCEPTANCE CRITERIA		
Criterion	**Validity**	**Explanation**
A Business Relevance		
A.1 Market Requirement	Essential ___ Desirable _ X__ Supportive ___	See Annex A
A.2 Regulatory Context	Essential ___ Desirable ___ Supportive ___ Not Relevant_X__	
B. Related Work		
B.1 Completion/Maintenance of current standards	Yes	See Annex A

	No___X	
B.2 Commitment to other organization	Yes ___ No__X_	
B.3 Other Source of standards	Yes ___ No__X_	
C. Technical Status		
C.1 Mature Technology	Yes _X_ No___	see Annex A
C.2 Prospective Technology	Yes _X_ No__	see Annex A
C.3 Models/Tools	Yes _X_ No___	see Annex A
D. Conformity Assessment and Interoperability		
D.1 Conformity Assessment	Yes ___ No __X_	
D.2 Interoperability	Yes _X__ No___	Tools – see Annex A
E. Other Justification		see Annex A

Notes to Proforma

A. Business Relevance. That which identifies market place relevance in terms of what problem is being solved and or need being addressed.

A.1. Market Requirement. When submitting a NP, the proposer shall identify the nature of the Market Requirement, assessing the extent to which it is essential, desirable or merely supportive of some other project.

A.2 Technical Regulation. If a Regulatory requirement is deemed to exist - e.g. for an area of public concern e.g. Information Security, Data protection, potentially leading to regulatory/public interest action based on the use of this voluntary international standard - the proposer shall identify this here.

B. Related Work. Aspects of the relationship of this NP to other areas of standardization work shall be identified in this section.

B.1 Competition/Maintenance. If this NP is concerned with completing or maintaining existing standards, those concerned shall be identified here.

B.2 External Commitment. Groups, bodies, or fora external to JTC1 to which a commitment has been made by JTC for cooperation and or collaboration on this NP shall be identified here.

B.3 External Std/Specification. If other activities creating standards or specifications in this topic area are known to exist or be planned, and which might be available to JTC1 as PAS, they shall be identified here.

C. Technical Status. The proposer shall indicate here an assessment of the extent to which the proposed standard is supported by current technology.

C.1 Mature Technology. Indicate here the extent to which the technology is reasonably stable and ripe for standardization.

C.2 Prospective Technology. If the NP is anticipatory in nature based on expected or forecasted need, this shall be indicated here.

C.3 Models/Tools. If the NP relates to the creation of supportive reference models or tools, this shall be indicated here.

D. Any other aspects of background information justifying this NP shall be indicated here.

D. Conformity Assessment and Interoperability

D.1 Indicate here if Conformity Assessment is relevant to your project. If so, indicate how it is addressed in your project plan.

D.2 Indicate here if Interoperability is relevant to your project. If so, indicate how it is addressed in your project plan.

Annex A

Additional Information
New Work Item Proposal for Petri net techniques

Rationale

Project 7.19.3 Petri net techniques, has been automatically cancelled by JTC1 procedures. The project's output document, ISO/IEC 15909 Software Engineering - High-level Petri Nets – Concepts, Definitions and Graphical Notation, reached FDIS stage after a successful FCD ballot in 1998.

The purpose of this new work item proposal is to re-instate Project 7.19.3 so that ISO/IEC 15909 can be finalised, and work that is continuing on developing a transfer format can also be standardised, within a multi-part standard. The multi-part standard may also include extensions for structuring facilities to manage large specifications (e.g. hierarchical constructs in Coloured Petri Nets) and those involving time, such as those that are currently embedded in Petri net tools.

Status

As reported in the FCD ballot summary (SC7 N2003, 29/10/1998) of the 21 P-members who voted, 17 approved (4 with comments), one disapproved (Germany) with comments, and three abstained (without comments). Thus the FCD was approved. It was understood that the text from the editing meeting would be the final text of the standard, so long as it passed the FDIS Yes/No ballot. To ensure a high quality standard, with maximum acceptance, the final editing meeting was held over from the Curitiba meeting in May 1999 to resolve the remaining technical issues raised by DIN. The editor could not attend the Madrid Plenary in 2000, and the draft disposition of comments document was finalised at the Nagoya meeting in May 2001. The text of the FDIS was circulated in October 2000 to WG19 members and Petri net experts, and all matters were resolved, apart from the final text of Informative Annex C, High-level Petri Net Schema. This was forwarded to Germany on 10 May 2002 for final comment.

There was a meeting of 60 Petri net experts at an evening session of the International Conference on Application and Theory of Petri Nets (PetriNets 2000), Aarhus Denmark, June 2000, to discuss SGML/XML based transfer formats for high-level Petri nets, at which several proposals were canvassed. It was agreed that such a format should be standardised as part of the

Petri net standardisation effort in ISO/IEC JTC1/SC7. At PetriNets 2001, it was agreed that Dr Albert Koelmans (UK), would provide co-ordination. An email list has been established to progress this standardisation work (PNX@informatik.hu-berlin.de).

Background

The development of an international Petri net Standard was discussed in ISO/IEC JTC1/SC7/WG11 at its meetings in Ottawa (June 94), Bonn (November 94) and Brisbane (June 95). At its meeting in Brisbane, WG11 agreed to the subdivision of Project 7.19 as the appropriate project for the proposed standard (see SC7 N1441). The ballot result (SC7 N1494) was known in March 1996 and it strongly supported the development of the standard, with 12 countries in favour, one abstention, and one against. A mature working draft was circulated to SC7 in February 1997 for comment. The editor's foreword to this circulated WD invited comment on the subdivision of the Petri net standard into 4 parts:

Part 1: Basic Definitions
Part 2: Syntaxes (Basic and Transfer)
Part 3: Modularization Extensions (e.g. Hierarchies)
Part 4: Time Extensions (e.g. Timed and Stochastic Petri nets)

as an appropriate way to handle the complexity of the Petri net standardisation effort as defined in the scope of the original project subdivision proposal (SC7 N1441). No objections were received to proceeding with this part structure.

ISO/IEC 15909 was balloted as a CD in 1997 (see SC7N1793) and as an FCD on 21 June 1998 (see SC7 N1947). The FCD ballot was successful (SC7 N2003) - 17 P-members approved (4 with comments), one disapproved (Germany) with comments, and three abstained (without comments). To ensure a high quality standard, with maximum acceptance, the final editing meeting was held over from the Curitiba SC7/WG11 meeting to resolve issues with those who were not present, in particular, representatives from DIN.

There were a total of 84 comments received by the editor. The editor processed comments that were meant to be input by National Bodies, (although not included in SC7 N2003) as agreed at the Curitiba meeting of SC7/WG11 in May 1999.

A draft disposition of comments document was circulated by email to all representatives of NBs and WG11 experts on 3 November 1998. The editing meeting was left open till the Curitiba

meeting of WG11 as part of the SC7 Plenary in Brazil, in order to finalise the disposition of comments. UK and Denmark responded positively to the draft disposition accepting all recommendations. The USA noted that all its comments had been accepted (see WG11 minutes - SC7 N2036). Australia confirmed it agreed with the disposition. The disposition of Japanese comments was agreed to at the Curitiba meeting. A detailed response from Germany was received on 18 November 1998, and responded to by the editor on 25 April 1999. All comments were resolved, except for the implementation of how to include symbolic markings in Germany's response of 10 May 1999. A revised draft of ISO/IEC 15909 was circulated to Petri net experts and to the WG19 secretary in October 2000. Responses from Petri net experts from the UK and USA were positive. The implementation of symbolic markings has been resolved with Germany. No other responses by NBs were received during this period. Thus all matters have been resolved, apart from the final text for Informative Annex C, High-level Petri Net Schema, which was forwarded to Germany on 10 May 2002, for final comment.

Scope and Field of Application

The scope of the project is the definition and standardization of what is known as a 'high-level' Petri net technique. Three major areas of work are envisaged, all of which fall within the scope of the original definition of Project 7.19.3 as circulated on 14 September 1995 (see SC7 N1441):

- Concepts, basic definitions, semantics and graphical notation;
- Transfer Format including Syntaxes (Basic and Transfer);
- Extensions including modularity constructs such as hierarchies and time extensions (e.g. Time and Stochastic Petri nets)

Area 1 forms the first part of the standard, and is documented in ISO/IEC FDIS 15909, SC7 N2634. This part provides a basic semantic model, an abstract mathematical definition of the technique based on universal algebra, a graphical syntax, and a mapping from the technique to the semantic model. It does not provide a concrete syntax for an inscription language that is necessary for the annotation of graphical elements as it only considers these inscriptions at an abstract mathematical level. A conformance clause is also included which depends on the net class and the technique's compliance with the semantics and notational conventions.

Area 2 would be standardised in the second part of the standard. This part is concerned with transfer formats and a basic inscription language syntax. It is envisaged that this will be achieved using SGML/XML. This part is concerned with the definition of the syntax and

encoding rules necessary for Petri net support tools to be able to transfer Petri net models of systems between each other with the aim of preserving their semantics and hence behaviour.

Part 2 builds on the basic definitions provided in Part 1 (ISO/IEC 15909-1) and may develop a basic inscription language syntax based on the transfer syntax. The transfer syntax will take into account extensibility particularly for the extensions that may cover modularity and time being considered in Part 3. It will also include graphical layout information that is not covered in Part 1.

The extensions (Area 3) would be standardised in Part 3. Modularity extensions, such as those developed for hierarchical Coloured Petri Nets (see Jensen's 3 volume book in the Bibliography), may involve constructs such as substitution places and transitions, and fusion places and transitions. Concepts from object orientation (e.g. Object Petri nets) may also be considered, as may extensions such as place capacity and inhibitor arcs. Time extensions to high-level Petri nets, include discrete time and stochastic extensions (distributions). They may also include priorities and probabilities. The time extensions provide rigorous support for the real-time specification and performance evaluation of systems to be developed and deployed in important sectors of the economy, including telecommunications, manufacturing, banking, transport, aerospace, computing, business organisation and defence.

Part 2 needs to take these extensions into account, and will provide the driving force behind them.

The field of application was well documented in the original definition of Project 7.19.3 (SC7 N1441), and is elaborated in ISO/IEC FDIS 15909 (SC7 N2634). In summary, the technique can be applied to a wide variety of discrete event concurrent systems, and in particular distributed systems. Generic fields of application include:

Development of requirements, specifications, designs and test suites
Descriptions of existing systems prior to re-engineering
Providing semantics for concurrent languages
Modelling of business and software processes
Simulation of systems to increase confidence
Functional analysis to prove correctness, especially for safety critical systems
Performance analysis of systems
Development of Petri net support tools and their interoperability

Areas where Petri nets have been applied include: avionics, banking, biological and chemical processes, business processes, communication protocols, computer hardware architectures, control systems, databases, defence command and control, distributed computing, electronic commerce, fault-tolerant systems, hospital procedures, information systems, Internet protocols and applications, legal processes, logistics, manufacturing systems, metabolic processes, music, nuclear power systems, operating systems, transport systems (including railway control), security systems, space, telecommunications and workflow.

An extensive web site has been developed for Petri Nets at

- http://www.daimi.au.dk/PetriNets

which can be consulted for further information.

Purpose and Justification

The purpose and justification for the project is well documented in the original proposal (SC7N1441), and includes: background, specific aims, beneficiaries, feasibility, timeliness, urgency and benefits. Here we shall just provide additional information on the need for the transfer format, the extensions and the part structure.

There are now over 45 Petri net tool sets that have been developed and listed via links with the Petri net home page (http://www.daimi.au.dk/PetriNets/). Some of these have been distributed widely. For example, Design/CPN has been licenced to about 750 organisations. Of the 45 tools listed, 15 are commercial tools developed by a number of companies in the USA and Europe.

It is now time to ensure that Petri net models produced by different tools can be transferred between the tools. This would facilitate important design activities such as:

- the use of specialised analysis capabilities associated with a particular tool or tools; and
- for distributed design teams to cooperate on the integration of large system designs.

It would also allow tool purchasers to upgrade to new tools without the cost of re-entry of their previous designs, nor the need to abandon previous tools, as they would be able to interwork.

For the practical application of high-level nets it is recognised that it is essential to have ways of structuring specifications, to allow them to be more easily understood and maintained. One purpose of this project is to develop the necessary extensions required to FDIS 15909 to support methods for structuring specifications.

Secondly, it is also recognised that for domains where real-time considerations are important

(for example for multimedia applications, and where performance guarantees are required) it is essential that the High-level Petri net technique provides the necessary support. This requires extensions to the basic definitions provided in Part 1. The extensions required have been well reported in books and the technical literature (see references), which makes the project feasible.

The justification for a multi-part standard is that it provides the means for managing the complexity of the standardisation effort. Experience in developing the basic definitions and graphical notation standard so far has shown that the current FDIS is over 40 pages, and covers a well defined and self contained piece of work. The Transfer Format work is more detailed, and will also be self contained. Modularity and time extensions are logically separate pieces of work, that will build on Part 1. The modularity constructs are concerned with making large specifications of systems readable, manageable and maintainable. The time extensions allow real-time systems (with hard deadlines) to be specified, and more generally timing information to be included in system models for the purpose of performance evaluation (to predict throughputs and delays, and to detect bottlenecks in systems). Both extensions are needed to make the standard applicable to practical (complex) systems development.

The justification for the multi-part standard is in accordance with ISO/IEC Directives Part 3, Third edition, 1997, clause 5.1 Subdivision of the subject matter.

Business Relevance

The main beneficiaries will be industrial sectors that are involved with developing concurrent and/or distributed systems, including aerospace, banking, computing, defence, manufacturing, telecommunications and transportation. Petri nets can also be used in understanding business processes (workflow) and in their re-engineering and this will effect many secondary and tertiary industries including government service organisations. The standard may also be used in the tertiary education and research sectors.

A Petri net standard would facilitate the exchange of specifications and designs written in Petri nets across national borders, thus assisting trade and global development teams. It would also facilitate the development of compatible Petri Net tool sets.

The standard can be mandated in tenders or contracts between purchasers and suppliers of systems, to ensure that requirements and design information is supplied in a form that can be evaluated using tools before implementation proceeds. This would provide unambiguous specifications, and executable models that can be simulated and analysed to greatly improve the

quality of specifications and to facilitate rapid prototyping, proof of concept and validation. The designs would then be used for maintenance purposes, where updates could be validated before implementation.

Technical Status

There has now been over 30 years of development of the techniques from research ideas to a level of maturity necessary for uptake by industry. During their development, many different variants of Petri nets and their extensions have occurred. The purpose of the standard will be to provide a reference definition that can be used both within and between organisations, to ensure a common understanding of the technique, and the specifications written using the technique.

Most of the techniques are quite mature with several text books available in a number of different languages and implemented in over 45 tool sets. However, research into the techniques continues. For example, it is not exactly clear which constructs should be used for modularity or for time extensions, but tools have already implemented variants of these features. In this sense, some of the features may be considered prospective.

Interoperability

The standard will create a transfer format to allow Petri net tool sets to exchange specifications that may have different concrete syntaxes, but have the same semantics.

Program of Work

Part 1 will use the Final Draft International Standard (FDIS 15909 Software Engineering - High Level Petri Nets - Concepts, Definitions and Graphical Notation) SC7 N2634 as its baseline document.

Part 2 would take the PNML (Petri Net Mark-up Language) proposal, (see [24,25] and http://www.informatik.hu-berlin.de/top/pnml) as the baseline. See also preparatory work at the end of this proposal.

Part 3 will build on the work of Part 1 and maintain compatibility with Part 2. Preparatory work for the extensions is discussed at the end of this proposal.

Schedule

Balloting and publication of the 3 parts of ISO/IEC 15909 is planned as follows:

Part	WD	CD	FCD	FDIS	IS
1	2002-9	2002-9	2002-9	2003-1	2003-7
2	2003-6	2004-6	2006-1	2006-6	2006-12
3	2004-1	2005-1	2006-1	2006-6	2006-12

Resources

The following resources are available and most have already been committed in the development of FDIS15909 and in the preparatory work for Part 2.

Country	People	**Commitment**
Australia	J.Billington	Editor, contribution
Canada	J. Berube	Reviewing
Denmark	K. Jensen, K. Mortensen, S. Christensen	Contribution
Finland	N. Husberg	Contribution
France	L. Petrucci	Contribution
Germany	E. Kindler, M. Weber	Contribution
Japan	H. Tadaumi	Contribution, Review
Korea	C-W Ro, S.H. Lee	Contribution, Review
USA	T. Murata	Reviewing
UK	D. Simpson, A Koelmans	Contribution

Reference Documents

1. ISO/IEC FCD 15909, Information Technology - High Level Petri Nets – Concepts, Definitions and Graphical Notation, 21 June 1998, ISO/IEC JTC1/SC7 N1947.

2. J. L. Peterson, *Petri Net Theory and the Modeling of Systems*, Prentice-Hall, N.J., 1981.

3. W. Reisig, *Petri Nets, An Introduction*, EATCS, Monographs on Theoretical Computer Science, W.Brauer, G. Rozenberg, A. Salomaa (Eds.), Springer Verlag, Berlin, 1985.

4. T. Murata, "Petri nets: properties, analysis and applications", Proc IEEE, Volume 77, No.4, pp.541-580, 1989.

5. B. Baumgarten, *Petri-Netze, Grundlagen und Anwendungen*, Wissenschaftsverlag, Mannheim, 1990.

6. K. Jensen, *Coloured Petri Nets*, Volume 1: Basic Concepts, Springer-Verlag 1997.

7. K. Jensen, *Coloured Petri Nets*, Volume 2: Analysis Methods, Springer-Verlag 1997.

8. K. Jensen, *Coloured Petri Nets*, Volume 3: Practical Use, Springer-Verlag 1997.

9. J. Desel and J. Esparza, *Free Choice Petri Nets*, Cambridge Tracts in Theoretical Computer Science 40, Cambridge University Press, 1995.

10. R. David and H. Alla, *Petri nets and Grafcet*, Prentice Hall, 1992.

11. A. A. Desrochers and R.Y. Al'Jaar, *Applications of Petri nets in Manufacturing Systems: Modelling, Control and Performance Analysis*, IEEE Press, 1995.

12. Advanced Course on Petri Nets, Bad Honnef, West Germany, September 1986. Published in 'Advances in Petri Nets' series, LNCS Vols 254, 255, 1987.

13. E. Best and C. Fernandez, "Notations and Terminology on Petri Net Theory", Arbeitspapiere der GMD 195, March 1987.

14. J. Billington, "Extensions to Coloured Petri Nets", Proceedings of the Third International Workshop on Petri Nets and Performance Models, Kyoto, Japan, 11-13 December, 1989, pp. 61-70.

15. J. Billington, "Many-sorted High-level Nets", invited paper in Proceedings of the Third International Workshop on Petri Nets and Performance Models, Kyoto, Japan, 11-13 December, 1989, pp. 166-179, also reprinted in K. Jensen, G. Rozenberg (Eds.) High-Level Petri Nets: Theory and Application, Springer-Verlag, 1991.

16. J. Billington, "Extensions to Coloured Petri Nets and their Application to Protocols", University of Cambridge Computer Laboratory Technical Report No. 222, May 1991.

17. W. Reisig, "Petri nets and algebraic specifications", TCS, Vol.80, pp.1-34, May, 1991.

18. W. Reisig, *Distributed Algorithms, Modeling and Analysis with Petri Nets*, Springer-Verlag, 1998.

19. J.K. Truss, "Discrete Mathematics for Computer Scientists", Addison-Wesley, 1991.

20. G. Wheeler, "A textual Syntax for describing Petri nets", FORESEE design document, Telecom Australia Research Laboratories, Version 2, April 1993.

21. A.M. Koelmans, "PNIF language definition", Version 2.2, July 1995, Computing Science Department, University of Newcastle upon Tyne, UK.

22. F. Bause, P. Kemper, P. Kritzinger, "Abstract Petri Net Notation", Petri net Newsletter, Vol. 49, pp 9-27.

23. R.B. Lyngso, T. Mailund, "Textual Interchange Format for High-level Petri Nets", Proc Workshop on Practical use of Coloured Petri Nets and Design/CPN, Department of Computer Science, University of Aarhus, PB-532 1998, pp 47-63 (revised version available from the authors).

24. Matthias Jungel, Ekkart Kindler and Michael Weber, "The Petri Net Markup Language", Petri Net Newsletter, 2000, No. 59, pages 24-29.
(The first description of PNML, http://www.informatik.hu-berlin.de/top/pnml/)

25. Michael Weber and Ekkart Kindler, "The Petri Net Markup Language", to appear in *Petri Net Technology for Communication Based Systems*, Lecture Notes in Computer Science, Springer-Verlag, 2002. (Note: The final description of PNML's concepts. **Abstract:** Petri Net Markup Language (PNML) is an XML-based interchange format for Petri nets. PNML supports

any version of Petri nets since new Petri net types can be defined by so-called Petri Net Type Definitions (PNTD). In this paper, we present the syntax and the semantics of PNML as well as the principles underlying its design. Moreover, we present an extension called *modular PNML*, which is a type independent module concept for Petri nets.)

26. M. Ajmone Marsan et al, *Modelling and Analysis with Generalised Stochastic Petri Nets*, Wiley, 1995.

27. F. Bause and P. Kritzinger, *Stochastic Petri Nets*, 1996 (publisher?)

28. R. German, *Performance Analysis of Communication Systems, Modeling with Non-Markovian Stochastic Petri Nets*, Wiley, UK, 2000.

29. C. Lindemann, *Performance Modelling with Deterministic and Stochastic Petri Nets*, John Wiley, 1998.

30. C. Lakos, "Object-oriented Petri nets" (several papers)

Note: Reference list is incomplete - need to include Diaz IEEE paper on Timed nets, plus others on hierarchy and OO.

Preparatory Work

Project Editor

Australia offers to provide the project editor:

Professor Jonathan Billington
University of South Australia, Australia
Fax: +61 8 8302 3384
Ph: +61 8 8302 3940
email: j.billington@unisa.edu.au

Work on the Standard

Currently the baseline for Part 1 was at FDIS stage with the text almost finalised.

Technical work on Part 2 has been in progress for several years within the Petri net community. A web page and email list has been established. A number of candidates exist for the transfer syntax, and they are listed in the references [20-25]. The transfer format of [21] has been implemented and used in experiments between Bristol University and The University of Newcastle upon Tyne. Consolidation of this work by the Petri net community commenced in 2000, and a transfer format is being produced, called PNML [24,25] – see

http://www.informatik.hu-berlin.de/top/pnml. An email list has been established for this work: PNX@informatik.hu-berlin.de, known as the Petri Net Interchange Format Mailing List. http://www.informatik.hu-berlin.de/top/PNX is the URL for standardisation of the interchange format. It includes an archive of email distributed over the PNX email list, which discusses the technical content.

Part 3 is at the preparatory stage. Hierarchical extensions to Coloured Petri nets have been reported in the literature [6] and applied to several industrial projects [8]. There has also been significant interest in object-oriented extensions (see [30] for example). The use of inhibitor arcs and place capacities has also been reported [14,16]. Timed and stochastic extensions are the subject of several books [26-29], and have been established since the early 1980s. Baseline material is thus available from these references, and also from the basic definitions provided in FDIS 15909.