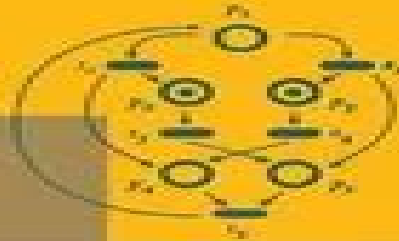Claude Girault

Rüdiger Valk

Petri Nets
for Systems Engineering

A Guide to Modeling, Verification,
and Applications

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Petri Nets For Systems Engineering

MengChu Zhou,Naiqi Wu

Petri Nets For Systems Engineering:

Petri Nets for Systems Engineering Claude Girault,Rüdiger Valk,2003 Using formal methods for the specification and verification of hardware and software systems is becoming increasingly important as systems increase in size and complexity The aim of the book is to illustrate progress in formal methods based on Petri net formalisms It presents both practical and theoretical foundations for the use of Petri nets in complex system engineering tasks In doing so it bridges the gap between Petri nets and the systems modeling and implementation process It contains a collection of examples arising from different fields such as flexible manufacturing telecommunication and workflow management systems Petri Nets for Systems Engineering Claude Girault,Rüdiger Valk,2013-01-08 Using formal methods for the specification and verification of hardware and software systems is becoming increasingly important as systems increase in size and complexity The aim of the book is to illustrate progress in formal methods based on Petri net formalisms It presents both practical and theoretical foundations for the use of Petri nets in complex system engineering tasks In doing so it bridges the gap between Petri nets and the systems modeling and implementation process It contains a collection of examples arising from different fields such as flexible manufacturing telecommunication and workflow management systems **Petri Nets for Systems Engineering** Claude Girault,Rüdiger Valk,2003 *The Impact of Petri Nets on System-of-systems Engineering* Kirsten Sinclair,2009 Abstract The successful engineering of a large scale system of systems project towards deterministic behaviour depends on integrating autonomous components using international communications standards in accordance with dynamic requirements To date their engineering has been unsuccessful no combination of top down and bottom up engineering perspectives is adopted and information exchange protocol and interfaces between components are not being precisely specified Various approaches such as modelling and architecture frameworks make positive contributions to system of systems specification but their successful implementation is still a problem One of the most popular modelling notations available for specifying systems UML is intuitive and graphical but also ambiguous and imprecise Supplying a range of diagrams to represent a system under development UML lacks simulation and exhaustive verification capability This shortfall in UML has received little attention in the context of system of systems and there are two major research issues 1 Where the dynamic behavioural diagrams of UML can and cannot be used to model and analyse system of systems 2 Determining how Petri nets can be used to improve the specification and analysis of the dynamic model of a system of systems specified using UML This thesis presents the strengths and weaknesses of Petri nets in relation to the specification of system of systems and shows how Petri net models can be used instead of conventional UML Activity Diagrams The model of the system of systems can then be analysed and verified using Petri net theory The Petri net formalism of behaviour is demonstrated using two case studies from the military domain The first case study uses Petri nets to specify and analyse a close air support mission This case study concludes by indicating the strengths weaknesses and shortfalls of the proposed formalism in system of systems specification The second

case study considers specification of a military exchange network parameters problem and the results are compared with the strengths and weaknesses identified in the first case study Finally the results of the research are formulated in the form of a Petri net enhancement to UML mapping existing activity diagram elements to Petri net elements **Petri Net Synthesis for Discrete Event Control of Manufacturing Systems** MengChu Zhou,F. Dicesare,2012-12-06 Petri Net Synthesis for Discrete Event Control of Manufacturing Systems develops two essential resource sharing concepts parallel and sequential mutual exclusions and theoretical results in Petri synthesis A parallel mutual exclusion PME is defined to model a resource shared by independent distributed processes and a sequential mutual exclusion is a sequential composition of PMEs modeling a resource shared by sequentially related processes A hybrid synthesis methodology for Petri net models and controllers is proposed using top down modular and bottom up design ideas and the mutual exclusion theory An aggregate Petri net model is refined by replacing places and or transitions with basic design modules which are mathematically and graphically described Petri net design methods are presented for such buffers as automatic storage and retrieval systems Using the proposed method synthesizes both Petri net structure and feasible initial markings guaranteeing that resulting Petri nets have desirable system properties such as freedom from deadlock and cyclic behavior A Petri net controller is extended to error recovery for automated manufacturing systems The theory can guarantee that the desired system properties achieved by the original design will be preserved when the controller is augmented to deal with an error in the prescribed methods Control code has been directly generated from Petri net definitions The algorithm and implementation details are given for a flexible manufacturing system Using the approach presented in Petri Net Synthesis for Discrete Event Control of Manufacturing Systems engineers and research workers can develop their own discrete event control applications and experiments **Application and Theory of Petri Nets 1998** Jörg Desel,Manuel Silva,2003-06-26 This volume contains the proceedings of the 19th annual International Conference on Application and Theory of Petri Nets The aim of the Petri net conference is to create a forum for the dissemination of the latest results in the application and theory of Petri nets It always takes place in the last week of June Typically there are 150 200 participants About one third of these come from industry while the rest are from universities and research institutions The conferences and a number of other activities are coordinated by a steering committee with the following members G Balbo Italy J Billington Australia G DeMichelis Italy C Girault France K Jensen Denmark S Kumagai Japan T Murata USA C A Petri Germany honorary member W Reisig Germany G Roucairol France G Rozenberg The Netherlands chairman M Silva Spain The 19th conference has been organized for the rst time in Portugal by the Department of Electrical Engineering of the Faculty of Sciences and Technology of the New University of Lisbon together with the Center for Intelligent Robotics of UNINOVA It takes place in Lisbon at the same time as EXPO 98 the last world exhibition of the 20th century *Petri Nets in System Engineering* Berndt Farwer,1997 Petri Nets for Modeling of Large Discrete Systems Reggie Davidrajuh,2021-09-21 This book offers a new Modular Petri Net as a

solution to the vast Petri net models It presents some approaches centering around modules known as Petri modules The goal of this book is to introduce a methodology in which Petri nets are moved to a new level In this new level large Petri net models are made of Petri modules which are independent and run on different computers This book also contains the literature study on modular Petri nets and definitions for the newer Petri modules Also algorithms for extracting Petri modules and algorithms for connecting Petri modules and applications are given in this book Besides the ideas and algorithms given in this book are implemented in the software General purpose Petri Net Simulator GPenSIM Hence with the use of this book the readers users would be able to know that real life discrete event systems could be modeled analyzed and performance optimized with GPenSIM **Application and Theory of Petri Nets 1993** Marco Ajmone Marsan,1993-06-07 This volume contains the proceedings of the 14th International Conference onApplication and Theory of Petri Nets The aim of the Petri net conferences is to create a forum for discussing progress in the application and theory of Petri nets Typically the conferences have 150 200 participants one third of whom come from industry while the rest are from universities and research institutes The volume includes three invited papers Modeling and enactment of workflow systems C A Ellis G J Nutt Interleaving functional and performance structural analysis of net models M Silva and FSPNs fluid stochastic Petri nets K S Trivedi V G Kulkarni together with 26 full papers selected from 102 submissions and 6 project papers <u>System Modeling and Control with Resource-Oriented Petri Nets</u> MengChu Zhou,Naiqi Wu,2018-09-03 Petri nets are widely used in modeling analysis and control of discrete event systems arising from manufacturing transportation computer and communication networks and web service systems However Petri net models for practical systems can be very large making it difficult to apply such models to real life problems System Modeling and Control with Resource Oriented Petri Nets introduces a new resource oriented Petri net ROPN model that was developed by the authors Not only does it successfully reduce model size but it also offers improvements that facilitate effective modeling analysis and control of automated and reconfigurable manufacturing systems Presenting the latest research in this novel approach this cutting edge volume provides proven theories and methodologies for implementing cost and time saving improvements to contemporary manufacturing systems It provides effective tools for deadlock avoidance deadlock free routing and deadlock free scheduling The authors supply simple and complex industrial manufacturing system examples to illustrate time tested concepts theories and approaches for solving real life application problems Written in a clear and concise manner the text covers applications to automated and reconfigurable manufacturing systems automated guided vehicle AGV systems semiconductor manufacturing systems and flexible assembly systems Explaining complex concepts in a manner that is easy to understand the authors provide the understanding and tools needed for more effective modeling analysis performance evaluation control and scheduling of engineering processes that will lead to more flexible and efficient manufacturing systems **Application and Theory of Petri Nets** ,2004 **Hardware Design and Petri Nets** Alex Yakovlev,Alexandre Yakovlev,Luis Gomes,Luciano

Lavagno,2000-02-29 Hardware Design and Petri Nets presents a summary of the state of the art in the applications of Petri nets to designing digital systems and circuits The area of hardware design has traditionally been a fertile field for research in concurrency and Petri nets Many new ideas about modelling and analysis of concurrent systems and Petri nets in particular originated in theory of asynchronous digital circuits Similarly the theory and practice of digital circuit design have always recognized Petri nets as a powerful and easy to understand modelling tool The ever growing demand in the electronic industry for design automation to build various types of computer based systems creates many opportunities for Petri nets to establish their role of a formal backbone in future tools for constructing systems that are increasingly becoming distributed concurrent and asynchronous Petri nets have already proved very effective in supporting algorithms for solving key problems in synthesis of hardware control circuits However since the front end to any realistic design flow in the future is likely to rely on more pragmatic Hardware Description Languages HDLs such as VHDL and Verilog it is crucial that Petri nets are well interfaced to such languages Hardware Design and Petri Nets is divided into five parts which cover aspects of behavioral modelling analysis and verification synthesis from Petri nets and STGs design environments based on high level Petri nets and HDLs and finally performance analysis using Petri nets Hardware Design and Petri Nets serves as an excellent reference source and may be used as a text for advanced courses on the subject   *Systems and Software Engineering* International Organization for Standardization,Technical Committee ISO/IEC JTC 1, Information technology. Subcommittee SC 7, Software and systems engineering,2013   **Formal Methods and Software Engineering** ,2003   **Lectures on Petri Nets I: Basic Models** Wolfgang Reisig,Grzegorz Rozenberg,1998-11-04 The two volume set originates from the Advanced Course on Petri Nets held in Dagstuhl Germany in September 1996 beyond the lectures given there additional chapters have been commissioned to give a well balanced presentation of the state of the art in the area Together with its companion volume Lectures on Petri Nets II Applications this book is the actual reference for the area and addresses professionals students lecturers and researchers who are interested in systems design and would like to learn to use Petri nets familiar with subareas of the theory or its applications and wish to view the whole area interested in learning about recent results presented within a unified framework planning to apply Petri nets in practical situations interested in the relationship of Petri nets to other models of concurrent systems   *Petri Net Technology for Communication-Based Systems* Hartmut Ehrig,Wolfgang Reisig,Grzegorz Rozenberg,Herbert Weber,2003-11-25 This state of the art survey in the Advances in Petri Nets series reports how various well established and novel Petri net notions and techniques can be employed for modelling communication based systems with a particular focus on workflow management and business processes The book builds on the success of a special program of the German Science Foundation DFG on Petri Net Technology as well as on broad participation from the international Petri net research community   Fifth International Conference on Systems Engineering, September 9-11, 1987, Holiday Inn Conference Center/I-675, Fairborn, Ohio Wright State University.

Department of Electrical Systems Engineering,IEEE Aerospace and Electronic Systems Society,Institute of Electrical and Electronics Engineers. Dayton Section,1987 **Understanding Petri Nets** Wolfgang Reisig,2013-07-03 With their intuitive graphical approach and expressive analysis techniques Petri nets are suitable for a wide range of applications and teaching scenarios and they have gained wide acceptance as a modeling technique in areas such as software design and control engineering The core theoretical principles have been studied for many decades and there is now a comprehensive research literature that complements the extensive implementation experience In this book the author presents a clear thorough introduction to the essentials of Petri nets He explains the core modeling techniques and analysis methods and he illustrates their usefulness with examples and case studies Part I describes how to use Petri nets for modeling all concepts are explained with the help of examples starting with a generic powerful model which is also intuitive and realistic Part II covers the essential analysis methods that are specific to Petri nets introducing techniques used to formulate key properties of system nets and algorithms for proving their validity Part III presents case studies each introducing new concepts properties and analysis techniques required for very different modeling tasks The author offers different paths among the chapters and sections the elementary strand for readers who wish to study only elementary nets the modeling strand for those who wish to study the modeling but not the analysis of systems and finally the elementary models of the modeling strand for those interested in technically simple but challenging examples and case studies The author achieves an excellent balance between consistency comprehensibility and correctness in a book of distinctive design Among its characteristics formal arguments are reduced to a minimum in the main text with many of the theoretical formalisms moved to an appendix the explanations are supported throughout with fully integrated graphical illustrations and each chapter ends with exercises and recommendations for further reading The book is suitable for students of computer science and related subjects such as engineering and for a broad range of researchers and practitioners *Operating Rules and Interoperability in Trans-National High-Speed Rail* Simon Collart-Dutilleul,2021-07-29 This book examines the problem of interoperability related to operating rules and gives an overview of the formal method approaches related to this subject The book examines the interoperability issues concerning implementation of European Rail Traffic Management System ERTMS while crossing a boarder It also looks at the implementing of the ERTMS and provides solutions regarding operating rules for ERTMS lines using formal methods and simulation tools The contributors will also discuss operating rule validation and formal methods for safety assessment *Formal Methods in Manufacturing* Javier Campos,Carla Seatzu,Xiaolan Xie,2018-09-03 Illustrated with real life manufacturing examples Formal Methods in Manufacturing provides state of the art solutions to common problems in manufacturing systems Assuming some knowledge of discrete event systems theory the book first delivers a detailed introduction to the most important formalisms used for the modeling analysis and control of manufacturing systems including Petri nets automata and max plus algebra explaining the advantages of each formal method It then employs the different

formalisms to solve specific problems taken from today s industrial world such as modeling and simulation supervisory control including deadlock prevention in a distributed and or decentralized environment performance evaluation including scheduling and optimization fault diagnosis and diagnosability analysis and reconfiguration Containing chapters written by leading experts in their respective fields Formal Methods in Manufacturing helps researchers and application engineers handle fundamental principles and deal with typical quality goals in the design and operation of manufacturing systems

Unveiling the Power of Verbal Art: An Psychological Sojourn through **Petri Nets For Systems Engineering**

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