

Robert Wille  
Rolf Drechsler

# Towards a Design Flow for Reversible Logic



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# Towards A Design Flow For Reversible Logic

**Kathleen Armour**



## **Towards A Design Flow For Reversible Logic:**

Towards a Design Flow for Reversible Logic Robert Wille, Rolf Drechsler, 2010-07-28 The development of computing machines found great success in the last decades. But the ongoing miniaturization of integrated circuits will reach its limits in the near future. Shrinking transistor sizes and power dissipation are the major barriers in the development of smaller and more powerful circuits. Reversible logic provides an alternative that may overcome many of these problems in the future. For low power design, reversible logic offers significant advantages since zero power dissipation will only be possible if computation is reversible. Furthermore, quantum computation profits from enhancements in this area because every quantum circuit is inherently reversible and thus requires reversible descriptions. However, since reversible logic is subject to certain restrictions, e.g., fanout and feedback are not directly allowed, the design of reversible circuits significantly differs from the design of traditional circuits. Nearly all steps in the design flow like synthesis, verification, or debugging must be redeveloped so that they become applicable to reversible circuits as well. But research in reversible logic is still at the beginning. No continuous design flow exists so far. In this book, contributions to a design flow for reversible logic are represented. This includes advanced methods for synthesis, optimization, verification, and debugging. Proceedings of the International Conference on Computational Intelligence and Sustainable Technologies Kedar Nath Das, Debasish Das, Anjan Kumar Ray, Ponnuthurai Nagaratnam Suganthan, 2022-02-12 This book presents the collection of the accepted research papers presented in the 1st International Conference on Computational Intelligence and Sustainable Technologies ICoCIST 2021. This edited book contains the articles related to the themes on artificial intelligence, machine learning, big data analysis, soft computing, techniques, pattern recognitions, sustainable infrastructural development, sustainable grid computing, and innovative technology for societal development, renewable energy, and innovations in Internet of Things (IoT). **Proceeding of Fifth International Conference on Microelectronics, Computing and Communication Systems** Vijay Nath, J. K. Mandal, 2021-09-09 This book presents high quality papers from the Fifth International Conference on Microelectronics Computing Communication Systems MCCS 2020. It discusses the latest technological trends and advances in MEMS and nanoelectronics, wireless communication, optical communication, instrumentation, signal processing, image processing, bioengineering, green energy, hybrid vehicles, environmental science, weather forecasting, cloud computing, renewable energy, RFID, CMOS sensors, actuators, transducers, telemetry systems, embedded systems, and sensor network applications. It includes papers based on original theoretical, practical, and experimental simulations, development, applications, measurements, and testing. The applications and solutions discussed here provide excellent reference material for future product development. *Advanced Computing and Systems for Security* Rituparna Chaki, Agostino Cortesi, Khalid Saeed, Nabendu Chaki, 2019-08-14 This book features extended versions of selected papers that were presented and discussed at the 6th International Doctoral Symposium on Applied Computation and Security Systems ACSS 2019 held in Kolkata, India, on 12-13

March 2019 Organized by the Departments of Computer Science Engineering and A K Choudhury School of Information Technology both from the University of Calcutta the symposium's international partners were Ca Foscari University of Venice Italy and Bialystok University of Technology Poland The chapters cover topics such as biometrics image processing pattern recognition algorithms cloud computing wireless sensor networks and security systems reflecting the various symposium sessions

**Recent Trends in Intelligent Systems and Next Generation Wireless Communication** Santos Kumar Das, Santanu Kumar Behera, 2025-08-19 This book is a collection of cutting edge research papers from the First National Conference on Intelligent Systems IoT and Wireless Communication for Society IIWCS 2024 It features contributions from researchers and practitioners worldwide sharing the latest findings in the fields of intelligent systems the Internet of Things IoT and wireless communication The volume covers novel techniques and methodologies in areas such as machine learning 5G and beyond communication RFID MEMS and VLSI engineering The proceedings are a valuable resource for researchers practitioners and students interested in the latest developments in intelligent systems IoT and wireless communication

Implementation and Application of Functional Languages Andy Gill, Jurriaan Hage, 2012-11-06 This book constitutes the thoroughly refereed post conference proceedings of the 23rd International Symposium on Implementation and Application of Functional Languages IFL 2011 held in Lawrence Kansas USA in October 2011 The 11 revised full papers presented were carefully reviewed and selected from 33 submissions The papers by researchers and practitioners who are actively engaged in the implementation and the use of functional and function based programming languages describe practical and theoretical work as well as applications and tools They discuss new ideas and concepts as well as work in progress and results

Principles of Big Graph: In-depth Insight, 2023-01-24 Principles of Big Graph In depth Insight Volume 128 in the Advances in Computer series highlights new advances in the field with this new volume presenting interesting chapters on a variety of topics including CESDAM Centered subgraph data matrix for large graph representation Bivariate cluster and suitability analysis of NoSQL Solutions for big graph applications An empirical investigation on Big Graph using deep learning Analyzing correlation between quality and accuracy of graph clustering geneBF Filtering protein coded gene graph data using bloom filter Processing large graphs with an alternative representation MapReduce based convolutional graph neural networks A comprehensive review Fast exact triangle counting in large graphs using SIMD acceleration A comprehensive investigation on attack graphs Qubit representation of a binary tree and its operations in quantum computation Modified ML KNN Role of similarity measures and nearest neighbor configuration in multi label text classification on big social network graph data Big graph based online learning through social networks Community detection in large scale real world networks Power rank An interactive web page ranking algorithm GA based energy efficient modelling of a wireless sensor network The major challenges of big graph and their solutions A review and An investigation on socio cyber crime graph Provides an update on the issues and challenges faced by current researchers

Updates on future research agendas Includes advanced topics for intensive research for researchers      Reversibility and Universality Andrew Adamatzky, 2018-02-26 This book is a tribute to Kenichi Morita's ideas and achievements in theoretical computer science reversibility and computationally universal mathematical machines It offers a unique source of information on universality and reversibility in computation and is an indispensable book for computer scientists mathematicians physicists and engineers Morita is renowned for his works on two dimensional language accepting automata complexity of Turing machines universality of cellular automata regular and context free array grammars and undecidability His high impact works include findings on parallel generation and parsing of array languages by means of reversible automata construction of a reversible automaton from Fredkin gates solving a firing squad synchronization problem in reversible cellular automata self reproduction in reversible cellular spaces universal reversible two counter machines solution of nondeterministic polynomial NP problems in hyperbolic cellular automata reversible P systems a new universal reversible logic element with memory and reversibility in asynchronous cellular automata Kenichi Morita's achievements in reversibility universality and theory of computation are celebrated in over twenty high profile contributions from his colleagues collaborators students and friends The theoretical constructs presented in this book are amazing in their diversity and depth of intellectual insight addressing queue automata hyperbolic cellular automata Abelian invertible automata number conserving cellular automata Brownian circuits chemical automata logical gates implemented via glider collisions computation in swarm networks picture arrays universal reversible counter machines input position restricted models of language acceptors descriptive complexity and persistence of cellular automata partitioned cellular automata firing squad synchronization algorithms reversible asynchronous automata reversible simulations of ranking trees Shor's factorization algorithms and power consumption of cellular automata      **Emerging Research in Electronics, Computer Science and Technology** V Sridhar, Holalu Seenappa Sheshadri, M C Padma, 2013-09-13 PES College of Engineering is organizing an International Conference on Emerging Research in Electronics Computer Science and Technology ICERECT 12 in Mandya and merging the event with Golden Jubilee of the Institute The Proceedings of the Conference presents high quality peer reviewed articles from the field of Electronics Computer Science and Technology The book is a compilation of research papers from the cutting edge technologies and it is targeted towards the scientific community actively involved in research activities      Computer Aided Verification Rupak Majumdar, Viktor Kunčák, 2017-07-11 The two volume set LNCS 10426 and LNCS 10427 constitutes the refereed proceedings of the 29th International Conference on Computer Aided Verification CAV 2017 held in Heidelberg Germany in July 2017 The total of 50 full and 7 short papers presented together with 5 keynotes and tutorials in the proceedings was carefully reviewed and selected from 191 submissions The CAV conference series is dedicated to the advancement of the theory and practice of computer aided formal analysis of hardware and software systems The conference covers the spectrum from theoretical results to concrete applications with an emphasis on practical

verification tools and the algorithms and techniques that are needed for their implementation

**Field-Coupled Nanocomputing** Neal G. Anderson, Sanjukta Bhanja, 2014-05-31 Field coupled nanocomputing FCN paradigms offer fundamentally new approaches to digital information processing that do not utilize transistors or require charge transport. Information transfer and computation are achieved in FCN via local field interactions between nanoscale building blocks that are organized in patterned arrays. Several FCN paradigms are currently under active investigation including quantum dot cellular automata QCA, molecular quantum cellular automata MQCA, nanomagnetic logic NML, and atomic quantum cellular automata AQCA. Each of these paradigms has a number of unique features that make it attractive as a candidate for post CMOS nanocomputing and each faces critical challenges to realization. This State of the Art Survey provides a snapshot of the current developments and novel research directions in the area of FCN. The book is divided into five sections. The first part, Field Coupled Nanocomputing Paradigms, provides valuable background information and perspectives on the QDCA, MQCA, NML, and AQCA paradigms and their evolution. The second section, Circuits and Architectures, addresses a wide variety of current research on FCN, including clocking strategies, logic synthesis, circuit design, and test logic in memory hardware security and architecture. The third section, Modeling and Simulation, considers the theoretical modeling and computer simulation of large FCN circuits as well as the use of simulations for gaining physical insight into elementary FCN building blocks. The fourth section, Irreversibility and Dissipation, considers the dissipative consequences of irreversible information loss in FCN circuits, their quantification, and their connection to circuit structure. The fifth section, The Road Ahead: Opportunities and Challenges, includes an edited transcript of the panel discussion that concluded the FCN 13 workshop.

**Reversible Logic Synthesis** Anas N. Al-Rabadi, 2012-12-06 For the first time in book form, this comprehensive and systematic monograph presents the methods for the reversible synthesis of logic functions and circuits. This methodology offers designers the capability to solve major problems in system design now and in the future, such as the high rate of power consumption and the emergence of quantum effects for highly dense ICs. The challenge addressed here is to design reliable systems that consume as little power as possible and in which the signals are processed and transmitted at very high speeds with very high signal integrity. Researchers in academia or industry and graduate students who work in logic synthesis, computer design, computer aided design tools, and low power VLSI circuit design will find this book a valuable resource.

**Byte**, 1994-07

**Dissertation Abstracts International**, 2008

**Applied Science & Technology Index**, 1996

**Design and Testing of Reversible Logic** Ashutosh Kumar Singh, Masahiro Fujita, Anand Mohan, 2019-07-29 The book compiles efficient design and test methodologies for the implementation of reversible logic circuits. The methodologies covered in the book are design approaches, test approaches, fault tolerance in reversible circuits, and physical implementation techniques. The book also covers the challenges and the reversible logic circuits to meet these challenges stimulated during each stage of work cycle. The novel computing paradigms are being explored to serve as a basis for fast and low power computation.

**Proceedings of**

the Cranfield Fluidics Conference C. J. Charnely, Herbert Simon Stephens, Thomas Ephraim Brock, 1967      **Synthesis of Reversible Logic** Md. Mazder Rahman, 2014 Reversible logic plays an important role in quantum computation Quantum computations are known to have massive parallelism and hence exponential speed up is possible in some algorithms Logic operations in quantum systems are unitary transformations that are reversible A computing system that is logically reversible can be physically reversible Therefore research in reversible logic can lead to the design of powerful computing devices The synthesis of reversible logic targeted to the construction of quantum circuits is significantly different from non reversible logic synthesis The underlying synthesis procedures start from Boolean function specifications and generate circuits that are realizable with quantum technologies In general for a given Boolean function the design flow employs a series of methods such as embedding the Boolean function into a reversible one finding a Multiple Controlled Toffoli MCT realization minimizing the Toffoli circuit decomposing the Toffoli circuit into a quantum circuit and optimizing the quantum circuit These approaches are mostly heuristics that show significant room for improvement The aim of this thesis is to improve existing heuristics One such optimization heuristic is template matching The current set of templates rewriting rules used in template matching is incomplete Moreover the exact mapping of gate sequences of a template to gate sequences of a circuit is a complex problem that has not been solved If minimal circuits are known then they can be used as comparison for heuristic methods However the entangled state a phenomenon in quantum computation makes it difficult to develop a synthesis method that gives minimal circuits Moreover different technologies have different constraints For example Ion Trapped technology requires Linear Nearest Neighbor LNN circuits Heuristics for constructing LNN circuits use SWAP gates that results in a dramatic increase in the number of gates There are many possibilities for modelling universal quantum gate libraries however which library would be the best suited for quantum technologies is an open question In this thesis we first present an exhaustive search method that finds minimal circuits of 3 qubits that serve as benchmarks We give a new definition of template with a set of properties that show that minimal circuits are embedded in templates Hence we prove that a complete set of templates has the power of obtaining a minimal circuit from any non minimal circuit by using template matching The properties of templates also lead us to the development of algorithms for constructing new templates A graph based data structure enables an efficient formulation as well as implementation of matching problems A set of algorithms for exact template matching is developed The efficiency of the proposed algorithms is verified by optimizing the standard benchmarks We analyse different models as well as minimal ways of constructing LNN circuits without the use of SWAP gates Our proposed heuristic takes less time to obtain reduced LNN circuits than other methods in the literature We suggest that if a 2 qubit function can be realized by a single 2 qubit quantum gate then a new gate library can be built By considering such a gate has unit quantum cost we find two different gate libraries that lead to significant cost reductions in realizing 3 qubit minimal circuits Pages ii iv      **Low Power Design Methodologies** Jan M. Rabaey, Massoud Pedram, 1996 Presents

coverage of various layers of the design hierarchy ranging from the technology circuit logic and architectural levels up to the system layer This book gives insight into the mechanisms of power dissipation in digital circuits and presents approaches to power reduction It introduces a global view of low power design methodologies      *Proceedings of the ... Midwest Symposium on Circuits and Systems* ,2004



## Whispering the Secrets of Language: An Psychological Journey through **Towards A Design Flow For Reversible Logic**

In a digitally-driven world where displays reign great and immediate connection drowns out the subtleties of language, the profound techniques and psychological nuances hidden within words usually get unheard. However, located within the pages of **Towards A Design Flow For Reversible Logic** a captivating literary treasure pulsating with raw thoughts, lies an extraordinary journey waiting to be undertaken. Published by a talented wordsmith, that charming opus attracts viewers on an introspective journey, delicately unraveling the veiled truths and profound affect resonating within the fabric of each word. Within the mental depths with this emotional evaluation, we shall embark upon a genuine exploration of the book is core subjects, dissect its captivating publishing model, and succumb to the powerful resonance it evokes deep within the recesses of readers hearts.

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