

# Principles And Practices Of Interconnection Networks

Interconnection Networks Principles and Practices of Interconnection Networks Topological Structure and Analysis of Interconnection Networks Design of Interconnection Networks for Programmable Logic Principles and Practices of Interconnection Networks Studies of Interconnection Networks with Applications in Broadcasting Studies of Interconnection Networks with Applications in Broadcasting Interconnection Networks for Large-scale Parallel Processing Crossbar-Based Interconnection Networks Design of Interconnection Networks for Programmable Logic Interconnection Networks A Unified Theory of Interconnection Network Structure, Rev. Ed Design and Analysis of Interconnection Networks for Partitionable Parallel Processing Systems Interconnection Network Reliability Evaluation Topology of Interconnection Networks with Given Degree and Diameter Interconnection Networks for Parallel and Distributed Computing Topology and Fault Tolerance of Interconnection Networks On the Design of Interconnection Networks for Multicomputers Studies of Interconnection Networks with Applications in Broadcasting Study of Interconnection Networks Jose Duato William James Dally Junming Xu Guy Lemieux William James Dally Calin Dan Morosan Calin D. Morosan Howard Jay Siegel Mohsen Jahanshahi Guy Lemieux Clyde P Kruskal Susan Diane Smith Neeraj Kumar Goyal Guillermo Pineda-Villavincencio YuQing Lin M. Ould-Khaoua Calin Dan Morosan Mohammad Hassan Peyravi Interconnection Networks Principles and Practices of Interconnection Networks Topological Structure and Analysis of Interconnection Networks Design of Interconnection Networks for Programmable Logic Principles and Practices of Interconnection Networks Studies of Interconnection Networks with Applications in Broadcasting Studies of Interconnection Networks with Applications in Broadcasting Interconnection Networks for Large-scale Parallel Processing Crossbar-Based Interconnection Networks Design of Interconnection Networks for Programmable Logic Interconnection Networks A Unified Theory of Interconnection Network Structure, Rev. Ed Design and Analysis of Interconnection Networks for Partitionable Parallel Processing Systems Interconnection Network Reliability Evaluation Topology of Interconnection Networks with Given Degree and Diameter Interconnection Networks for Parallel and Distributed Computing Topology and Fault Tolerance of Interconnection Networks On the Design of Interconnection Networks for Multicomputers Studies of Interconnection Networks with Applications in Broadcasting Study of Interconnection Networks Jose Duato William James Dally Junming Xu Guy Lemieux William

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the performance of most digital systems today is limited by their communication or interconnection not by their logic or memory as designers strive to make more efficient use of scarce interconnection bandwidth interconnection networks are emerging as a nearly universal solution to the system level communication problems for modern digital systems interconnection networks have become pervasive in their traditional application as processor memory and processor processor interconnect point to point interconnection networks have replaced buses in an ever widening range of applications that include on chip interconnect switches and routers and i o systems in this book the authors present in a structured way the basic underlying concepts of most interconnection networks and provide representative solutions that have been implemented in the industry or proposed in the research literature gives a coherent comprehensive treatment of the entire field presents a formal statement of the basic concepts alternative design choices and design trade offs provides thorough classifications clear descriptions accurate definitions and unified views to structure the knowledge on interconnection networks focuses on issues critical to designers

this book offers a detailed and comprehensive presentation of the basic principles of interconnection network design clearly illustrating them with numerous examples and case studies it incorporates hardware level descriptions of concepts

the advent of very large scale integrated circuit technology has enabled the construction of very complex and large interconnection networks by most accounts the next generation of supercomputers will achieve its gains by increasing the number of processing elements rather than by using faster processors the most difficult technical problem in constructing a supercom puter will be the design of the interconnection network through which the processors communicate selecting an appropriate and adequate topological structure of interconnection networks will become a critical issue on which many research efforts have been made over the past decade the book is aimed to attract the readers attention to such an important research area graph theory is a fundamental and powerful mathematical tool for de signing and analyzing interconnection networks since the topological struc ture of an interconnection network is a graph this fact has been univer sally accepted by computer scientists and engineers this book provides the most basic problems concepts and well established results on the topological structure and analysis of interconnection networks in the language of graph theory the material originates from a vast amount of literature but the theory presented is developed

carefully and skillfully the treatment is generally self contained and most stated results are proved no exercises are explicitly exhibited but there are some stated results whose proofs are left to the reader to consolidate his understanding of the material

programmable logic devices plds have become the key implementation medium for the vast majority of digital circuits designed today while the highest volume devices are still built with full fabrication rather than field programmability the trend towards ever fewer asics and more fpgas is clear this makes the field of pld architecture ever more important as there is stronger demand for faster smaller cheaper and lower power programmable logic plds are 90 routing and 10 logic this book focuses on that 90 that is the programmable routing the manner in which the programmable wires are connected and the circuit design of the programmable switches themselves anyone seeking to understand the design of an fpga needs to become literate in the complexities of programmable routing architecture this book builds on the state of the art of programmable interconnect by providing new methods of investigating and measuring interconnect structures as well as new programmable switch basic circuits the early portion of this book provides an excellent survey of interconnection structures and circuits as they exist today lemieux and lewis then provide a new way to design sparse crossbars as they are used in plds and show that the method works with an empirical validation this is one of a few routing architecture works that employ analytical methods to deal with the routing architecture design the analysis permits interesting insights not typically possible with the standard empirical approach

one of the greatest challenges faced by designers of digital systems is optimizing the communication and interconnection between system components interconnection networks offer an attractive and economical solution to this communication crisis and are fast becoming pervasive in digital systems current trends suggest that this communication bottleneck will be even more problematic when designing future generations of machines consequently the anatomy of an interconnection network router and science of interconnection network design will only grow in importance in the coming years this book offers a detailed and comprehensive presentation of the basic principles of interconnection network design clearly illustrating them with numerous examples chapter exercises and case studies it incorporates hardware level descriptions of concepts allowing a designer to see all the steps of the process from abstract design to concrete implementation case studies throughout the book draw on extensive author experience in designing interconnection networks over a period of more than twenty years providing real world examples of what works and what doesn't tightly couples concepts with implementation costs to facilitate a deeper understanding of the tradeoffs in the design of a practical network a set of examples and exercises in every chapter help the reader to fully

understand all the implications of every design decision

the exponential growth of interconnection networks transformed the communication primitives into an important area of research one of these primitives is the one to all communication i.e. broadcasting its presence in areas such as static and mobile networks internet messaging supercomputing multimedia epidemic algorithms replicated databases rumors and virus spreading to mention only a few shows the relevance of this primitive in this thesis we focus on the study of interconnection networks from the perspective of two main problems in broadcasting the minimum broadcast time problem and the minimum broadcast graph problem both problems are discussed under the 1 port constant model which assumes that each node of the network can communicate with only one other node at a time and the transmitting time is constant regardless of the size of the message in the first part we introduce the minimum broadcast time function and we present two new properties of this function one of the properties yields an iterative heuristic for the minimum broadcast time problem which is the first iterative approach in approximating the broadcast time of an arbitrary graph in the second part we give exact upper and lower bounds for the number of broadcast schemes in graphs we also propose an algorithm for enumerating all the broadcast schemes and a random algorithm for broadcasting in the third part we present a study of the spectra of knödel graph and their applications this study is motivated by the fact that among the three known infinite families of minimum broadcast graphs namely the hypercube the recursive circulant and the knödel graph the last one has the smallest diameter in the last part we introduce a new measure for the fault tolerance of an interconnection network which we name the global fault tolerance based on this measure we make a comparative study for the above mentioned classes of minimum broadcast graphs along with other classes of graphs with good communication properties

parallel computer systems are being used to forecast the weather make maps simulate chemical reactions control air traffic guide missiles provide robots with vision and manage ballistic missile defense a major problem in designing large scale parallel systems is the construction of an interconnection network to provide interprocessor communications this book presents the theoretical basis and a number of case studies that demonstrate how this work is done this revision includes the most recent research in the field

this unique text reference provides an overview of crossbar based interconnection networks offering novel perspectives on these important components of high performance parallel processor systems a particular focus is placed on solutions to the blocking and scalability problems topics and features introduces the fundamental concepts in interconnection networks in multi processor systems

including issues of blocking scalability and crossbar networks presents a classification of interconnection networks and provides information on recognizing each of the networks examines the challenges of blocking and scalability and analyzes the different solutions that have been proposed reviews a variety of different approaches to improve fault tolerance in multistage interconnection networks discusses the scalable crossbar network which is a non blocking interconnection network that uses small sized crossbar switches as switching elements this invaluable work will be of great benefit to students researchers and practitioners interested in computer networks parallel processing and reliability engineering the text is also essential reading for course modules on interconnection network design and reliability

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a unified theory of interconnection network structure by clyde p kruskal and marc snir presents a comprehensive approach to understanding and designing interconnection networks this revised edition explores the fundamental principles that govern the structure and performance of these networks which are crucial for parallel processing and distributed computing the book delves into various network topologies and their properties offering a unified framework for analyzing their behavior key concepts include network diameter connectivity and routing algorithms this work is essential reading for computer scientists and engineers seeking a deeper understanding of interconnection network design this work has been selected by scholars as being culturally important

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a single instruction stream multiple data stream simd computer performs one algorithm single instruction stream on vectors of data of a control unit cu processing elements pes and an interconnection network the cu broadcasts instructions to the  $n$  pes where  $n$  is a power of two the interconnection network is the mechanism that allows pes to pass data among themselves four types of interconnection networks are discussed in this work the shuffle exchange network the cube network the illiac network and the plus minus 2 pm2i network each type has been discussed in the literature and used in an existing or proposed machine design for each of these four network types different hardware structures are considered a recirculating network consists of one stage of switches that is reused until the data reach their final destinations a combinational logic multistage network consists of several stages of switches and usually data is transferred in one pass through the network in pipelined multistage networks which are introduced registers are inserted after each stage of a combinational logic multistage network the data are divided into segments and these segments are passed in a parallel pipelined manner hardware implementations for recirculating combinational logic multistage and pipelined multistage networks are presented and analyzed

this book presents novel and efficient tools techniques and approaches for reliability evaluation reliability analysis and design of reliable communication networks using graph theoretic concepts in recent years human beings have become largely dependent on communication networks such as computer communication networks telecommunication networks mobile switching networks etc for their day to day activities in today s world humans and critical machines depend on these communication networks to work properly failure of these communication networks can result in situations where people may find themselves isolated helpless and exposed to hazards it is a fact that every component or system can fail and its failure probability increases with size and complexity the

main objective of this book is to devise approaches for reliability modeling and evaluation of such complex networks such evaluation helps to understand which network can give us better reliability by their design new designs of fault tolerant interconnection network layouts are proposed which are capable of providing high reliability through path redundancy and fault tolerance through reduction of common elements in paths this book covers the reliability evaluation of various network topologies considering multiple reliability performance parameters two terminal reliability broadcast reliability all terminal reliability and multiple sources to multiple destinations reliability

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