

# *The Microarchitecture of Pipelined and Superscalar Computers*

Amos R. Omondi

Springer Science+Business Media, B.V.

# Microarchitecture Of Pipelined And Superscalar Computers

**David A. Patterson, John L. Hennessy**



## **Microarchitecture Of Pipelined And Superscalar Computers:**

The Microarchitecture of Pipelined and Superscalar Computers Amos R. Omondi, 2013-03-09 This book is intended to serve as a textbook for a second course in the implementation of microarchitecture of computer architectures. The subject matter covered is the collection of techniques that are used to achieve the highest performance in single processor machines; these techniques center the exploitation of low level parallelism temporal and spatial in the processing of machine instructions. The target audience consists of students in the final year of an undergraduate program or in the first year of a postgraduate program in computer science, computer engineering or electrical engineering. Professional computer designers will also find the book useful as an introduction to the topics covered. Typically, the author has used the material presented here as the basis of a full semester undergraduate course or a half semester post graduate course with the other half of the latter devoted to multiple processor machines. The background assumed of the reader is a good first course in computer architecture and implementation to the level in, say, *Computer Organization and Design* by D Patterson and H Hennessy and familiarity with digital logic design. The book consists of eight chapters. The first chapter is an introduction to all of the main ideas that the following chapters cover in detail. The topics covered are the main forms of pipelining used in high performance uniprocessors, a taxonomy of the space of pipelined processors and performance issues. It is also intended that this chapter should be readable as a brief stand alone survey.

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accessible to both graduate and undergraduate students Complex practices are distilled into foundational principles to reveal the authors insights and hands on experience in the effective design of contemporary high performance micro processors for mobile desktop and server markets Key theoretical and foundational principles are presented in a systematic way to ensure comprehension of important implementation issues The text presents fundamental concepts and foundational techniques such as processor design pipelined processors memory and I O systems and especially superscalar organization and implementations Two case studies and an extensive survey of actual commercial superscalar processors reveal real world developments in processor design and performance A thorough overview of advanced instruction flow techniques including developments in advanced branch predictors is incorporated Each chapter concludes with homework problems that will institute the groundwork for emerging techniques in the field and an introduction to multiprocessor systems

**Microprocessor Architecture** Jean-Loup Baer,2009-12-07 This book gives a comprehensive description of the architecture of microprocessors from simple in order short pipeline designs to out of order superscalars It discusses topics such as The policies and mechanisms needed for out of order processing such as register renaming reservation stations and reorder buffers Optimizations for high performance such as branch predictors instruction scheduling and load store speculations Design choices and enhancements to tolerate latency in the cache hierarchy of single and multiple processors State of the art multithreading and multiprocessing emphasizing single chip implementations Topics are presented as conceptual ideas with metrics to assess the performance impact if appropriate and examples of realization The emphasis is on how things work at a black box and algorithmic level The author also provides sufficient detail at the register transfer level so that readers can appreciate how design features enhance performance as well as complexity Memory Systems and Pipelined Processors Harvey G. Cragon,1996 Memory Systems and Pipelined Processors *Processor Microarchitecture* Antonio Gonzalez,Fernando Latorre,Grigorios Magklis,2022-05-31 This lecture presents a study of the microarchitecture of contemporary microprocessors The focus is on implementation aspects with discussions on their implications in terms of performance power and cost of state of the art designs The lecture starts with an overview of the different types of microprocessors and a review of the microarchitecture of cache memories Then it describes the implementation of the fetch unit where special emphasis is made on the required support for branch prediction The next section is devoted to instruction decode with special focus on the particular support to decoding x86 instructions The next chapter presents the allocation stage and pays special attention to the implementation of register renaming Afterward the issue stage is studied Here the logic to implement out of order issue for both memory and non memory instructions is thoroughly described The following chapter focuses on the instruction execution and describes the different functional units that can be found in contemporary microprocessors as well as the implementation of the bypass network which has an important impact on the performance Finally the lecture concludes with the commit stage where it describes how the architectural state is updated and recovered

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**Essentials of Computer Organization and Architecture** Linda Null, Julia Lobur, 2014-02-17 In its fourth edition this book focuses on real world examples and practical applications and encourages students to develop a big picture understanding of how essential organization and architecture concepts are applied in the computing world In addition to direct correlation with the ACM IEEE CS2013 guidelines for computer organization and architecture the text exposes readers to the inner workings of a modern digital computer through an integrated presentation of fundamental concepts and principles It includes the most up to the minute data and resources available and reflects current technologies including tablets and cloud computing All new exercises expanded discussions and feature boxes in every chapter implement even more real world applications and current data and many chapters include all new examples

**Essentials of Computer Organization and Architecture with Navigate Advantage Access** Linda Null, 2023-04-13 Essentials of Computer Organization and Architecture focuses on the function and design of the various components necessary to process information digitally This title presents computing systems as a series of layers taking a bottom up approach by starting with low level hardware and progressing to higher level software Its focus on real world examples and practical applications encourages students to develop a big picture understanding of how essential organization and architecture concepts are applied in the computing world In addition to direct correlation with the ACM IEEE guidelines for computer organization and architecture the text exposes readers to the inner workings of a modern digital computer through an integrated presentation of fundamental concepts and principles

*Heterogeneous Computing with OpenCL 2.0* David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, 2015-06-18 Heterogeneous Computing with OpenCL 2.0 teaches OpenCL and parallel programming for complex systems that may include a variety of device architectures multi core CPUs GPUs and fully integrated Accelerated Processing Units APUs This fully revised edition includes the latest enhancements in OpenCL 2.0 including Shared virtual memory to increase programming flexibility and reduce data transfers that consume resources Dynamic parallelism which reduces processor load and avoids bottlenecks Improved imaging support and integration with OpenGL Designed to work on multiple platforms OpenCL will help you more effectively program for a heterogeneous future Written by leaders in the parallel computing and OpenCL communities this book explores memory spaces optimization techniques extensions debugging and profiling Multiple case studies and examples illustrate high performance algorithms distributing work across heterogeneous systems embedded domain specific languages and will give you hands on OpenCL experience to

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*Computer Architecture and Implementation* Harvey G. Cragon, 2000-02-13 This textbook provides a clear and concise introduction to computer architecture and implementation Two important themes are interwoven throughout the book The first is an overview of the major concepts and design philosophies of computer architecture and organization The second is the early introduction and use of analytic modeling of computer performance A unique feature of the book is that memory systems are discussed before processor implementations The book contains many worked examples and over 130 homework exercises It is an ideal textbook for a one semester undergraduate course in computer architecture and implementation

**Computer Organisation and Architecture** Pranabananda Chakraborty, 2020-09-30 Computer organization and architecture is becoming an increasingly important core subject in the areas of computer science and its applications and information technology constantly steers the relentless revolution going on in this discipline This textbook demystifies the state of the art using a simple and step by step development from traditional fundamentals to the most advanced concepts entwined with this subject maintaining a reasonable balance among various theoretical principles numerous design approaches and their actual practical implementations Being driven by the diversified knowledge gained directly from working in the constantly changing environment of the information technology IT industry the author sets the stage by describing the modern issues in different areas of this subject He then continues to effectively provide a comprehensive source of material with exciting new developments using a wealth of concrete examples related to recent regulatory changes in the modern design and architecture of different categories of computer systems associated with real life instances as case studies ranging from micro to mini supermini mainframes cluster architectures massively parallel processing MPP systems and even supercomputers with commodity processors Many of the topics that are briefly discussed in this book to conserve space for new materials are elaborately described from the design perspective to their ultimate practical implementations with representative schematic diagrams available on the book's website

**Key Features**

- Microprocessor evolutions and their chronological improvements with illustrations taken from Intel Motorola and other leading families
- Multicore concept and subsequent multicore processors a new standard in processor design
- Cluster architecture a vibrant organizational and architectural development in building up massively distributed parallel systems
- InfiniBand a high speed link for use in cluster system architecture providing a single system image
- FireWire a high speed serial bus used for both isochronous real time data transfer and asynchronous applications especially needed in multimedia and mobile phones
- Evolution of embedded systems and their specific characteristics
- Real time systems and their major

design issues in brief Improved main memory technologies with their recent releases of DDR2 DDR3 Rambus DRAM and Cache DRAM widely used in all types of modern systems including large clusters and high end servers DVD optical disks and flash drives pen drives RAID a common approach to configuring multiple disk arrangements used in large server based systems A good number of problems along with their solutions on different topics after their delivery Exhaustive material with respective figures related to the entire text to illustrate many of the computer design organization and architecture issues with examples are available online at <http://crcpress.com> 9780367255732 This book serves as a textbook for graduate level courses for computer science engineering information technology electrical engineering electronics engineering computer science BCA MCA and other similar courses

**Parallel Computer Organization and Design** Michel Dubois,Murali Annavaram,Per Stenström,2012-08-30 Teaching fundamental design concepts and the challenges of emerging technology this textbook prepares students for a career designing the computer systems of the future In depth coverage of complexity power reliability and performance coupled with treatment of parallelism at all levels including ILP and TLP provides the state of the art training that students need The whole gamut of parallel architecture design options is explained from core microarchitecture to chip multiprocessors to large scale multiprocessor systems All the chapters are self contained yet concise enough that the material can be taught in a single semester making it perfect for use in senior undergraduate and graduate computer architecture courses The book is also teeming with practical examples to aid the learning process showing concrete applications of definitions With simple models and codes used throughout all material is made open to a broad range of computer engineering science students with only a basic knowledge of hardware and software

**Computer Organization and Design RISC-V Edition** David A. Patterson,John L. Hennessy,2017-04-13 The new RISC V Edition of Computer Organization and Design features the RISC V open source instruction set architecture the first open source architecture designed to be used in modern computing environments such as cloud computing mobile devices and other embedded systems With the post PC era now upon us Computer Organization and Design moves forward to explore this generational change with examples exercises and material highlighting the emergence of mobile computing and the Cloud Updated content featuring tablet computers Cloud infrastructure and the x86 cloud computing and ARM mobile computing devices architectures is included An online companion Web site provides advanced content for further study appendices glossary references and recommended reading

**Readings in Hardware/Software Co-Design** Giovanni De Micheli,Rolf Ernst,Wayne Wolf,2002 This title serves as an introduction and reference for the field with the papers that have shaped the hardware software co design since its inception in the early 90s

*Modern Embedded Computing* Peter Barry,Patrick Crowley,2012-01-27 Modern embedded systems are used for connected media rich and highly integrated handheld devices such as mobile phones digital cameras and MP3 players This book provides an understanding of the platform architecture of modern embedded computing systems that drive mobile devices

**STRUCTURED COMPUTER ORGANIZATION** ,1996

**Handbook of Computer Architecture** Anupam Chattopadhyay, 2024-12-20 This handbook presents the key topics in the area of computer architecture covering from the basic to the most advanced topics including software and hardware design methodologies It will provide readers with the most comprehensive updated reference information covering applications in single core processors multicore processors application specific processors reconfigurable architectures emerging computing architectures processor design and programming flows test and verification This information benefits the readers as a full and quick technical reference with a high level review of computer architecture technology detailed technical descriptions and the latest practical applications

**Readings in Computer Architecture** Mark D. Hill, Gurindar S. Sohi, 2000 Offering a carefully reviewed selection of over 50 papers illustrating the breadth and depth of computer architecture this text includes insightful introductions to guide readers through the primary sources

**Computer Organization and Architecture** Stallings, 2008-02



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