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Kay A. Robbins
Steven Robbins

The Cray X-MP/Model 24

A Case Study in Pipelined Architecture and Vector Processing

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Authors

Kay A. Robbins
Steven Robbins
Division of Mathematics, Computer Science, and Statistics
The University of Texas at San Antonio
San Antonio, TX 78285, USA

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Preface

This monograph examines the issues relevant to the design of vector and pipelined computer systems. The Cray X-MP/24 is used as a case study to examine how design tradeoffs affect performance. Enough technical details are provided so that a reader may work out timings for the Cray X-MP without reference to a hardware manual.

We hope that a serious look at the details of the design will give the reader insights that a superficial discussion cannot yield. Our study left us with a great appreciation of the machine and an admiration for its designers. The insights we have given will be useful to the scientist who would like to obtain maximum performance from a vector machine, to the computer science student, and to the compiler writer. This monograph can also be used to supplement a regular textbook such as Baer [2] or Stone [44] in a graduate or senior level course in computer architecture.

The book begins with an overview of the Cray X-MP system. Chapter 2 discusses various aspects of control including the instruction cycle, the management of the instruction buffers, and the instruction issue mechanism. The scalar section is examined in Chapter 3 and the addressing mechanism is examined in Chapter 4. Chapter 5 discusses vectorization and chaining. Chapter 6 looks at memory access and conflict resolution. Multi-tasking and interprocessor communication are introduced in Chapter 7. Appendix A gives a PMS diagram of the Cray X-MP, and Appendix B shows the exchange package for the Cray X-MP. Appendix C lists the Lawrence Livermore loops, a standard benchmark for scientific computing. Appendix D shows a list of sample programs and discusses some of the more subtle aspects of performing accurate instruction timings. Appendix E contains a complete list of Cray assembly language instructions and their timings. Appendix F contains the Users Manual for XMPSIM, a Cray simulator which runs on an IBM PC and is available from the authors.

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