

HETEROGENEOUS SYSTEM ARCHITECTURE

A NEW COMPUTE PLATFORM
INFRASTRUCTURE



EDITED BY WEN-MET W. HWU

Arno Puder, Kay Römer, Frank Pilhofer

Heterogeneous System Architecture Wen-mei W. Hwu, 2015-11-20 Heterogeneous Systems Architecture a new compute platform infrastructure presents a next generation hardware platform and associated software that allows processors of different types to work efficiently and cooperatively in shared memory from a single source program HSA also defines a virtual ISA for parallel routines or kernels which is vendor and ISA independent thus enabling single source programs to execute across any HSA compliant heterogeneous processer from those used in smartphones to supercomputers The book begins with an overview of the evolution of heterogeneous parallel processing associated problems and how they are overcome with HSA Later chapters provide a deeper perspective on topics such as the runtime memory model queuing context switching the architected queuing language simulators and tool chains Finally three real world examples are presented which provide an early demonstration of how HSA can deliver significantly higher performance thru C based applications Contributing authors are HSA Foundation members who are experts from both academia and industry Some of these distinguished authors are listed here in alphabetical order Yeh Ching Chung Benedict R Gaster Juan G mez Luna Derek Hower Lee Howes Shih Hao HungThomas B Jablin David Kaeli Phil Rogers Ben Sander I Jui Ray Sung Provides clear and concise explanations of key HSA concepts and fundamentals by expert HSA Specification contributors Explains how performance bound programming algorithms and application types can be significantly optimized by utilizing HSA hardware and software features Presents HSA simply clearly and concisely without reading the detailed HSA Specification documents Demonstrates ideal mapping of processing resources from CPUs to many other heterogeneous processors that comply with **HSA Specifications** Heterogeneous Computing Architectures Olivier Terzo, Karim Djemame, Alberto Scionti, Clara Pezuela, 2019-09-10 Heterogeneous Computing Architectures Challenges and Vision provides an updated vision of the state of the art of heterogeneous computing systems covering all the aspects related to their design from the architecture and programming models to hardware software integration and orchestration to real time and security requirements The transitions from multicore processors GPU computing and Cloud computing are not separate trends but aspects of a single trend mainstream computers from desktop to smartphones are being permanently transformed into heterogeneous supercomputer clusters The reader will get an organic perspective of modern heterogeneous systems and their future evolution Automatically Migrating Sequential Applications to Heterogeneous System Architecture [1][1,2018]

An Open-Source Research Platform for Heterogeneous Systems on Chip Andreas Dominic Kurth,2022-10-05 Heterogeneous systems on chip HeSoCs combine general purpose feature rich multi core host processors with domain specific programmable many core accelerators PMCAs to unite versatility with energy efficiency and peak performance By virtue of their heterogeneity HeSoCs hold the promise of increasing performance and energy efficiency compared to homogeneous multiprocessors because applications can be executed on hardware that is designed for them However this

heterogeneity also increases system complexity substantially This thesis presents the first research platform for HeSoCs where all components from accelerator cores to application programming interface are available under permissive open source licenses We begin by identifying the hardware and software components that are required in HeSoCs and by designing a representative hardware and software architecture We then design implement and evaluate four critical HeSoC components that have not been discussed in research at the level required for an open source implementation First we present a modular topology agnostic high performance on chip communication platform which adheres to a state of the art industry standard protocol We show that the platform can be used to build high bandwidth e q 2 5 GHz and 1024 bit data width end to end communication fabrics with high degrees of concurrency e g up to 256 independent concurrent transactions Second we present a modular and efficient solution for implementing atomic memory operations in highly scalable many core processors which demonstrates near optimal linear throughput scaling for various synthetic and real world workloads and requires only 0.5 kGE per core Third we present a hardware software solution for shared virtual memory that avoids the majority of translation lookaside buffer misses with prefetching supports parallel burst transfers without additional buffers and can be scaled with the workload and number of parallel processors. Our work improves accelerator performance for memory intensive kernels by up to 4 Fourth we present a software toolchain for mixed data model heterogeneous compilation and OpenMP offloading Our work enables transparent memory sharing between a 64 bit host processor and a 32 bit accelerator at overheads below 0.7 % compared to 32 bit only execution Finally we combine our contributions to a research platform for state of the art HeSoCs and demonstrate its performance and flexibility **Scalable Applications on Heterogeneous System Architectures** Robert Dietrich, 2019 Research Anthology on Architectures, Frameworks, and Integration Strategies for Distributed and Cloud Computing Management Association, Information Resources, 2021-01-25 Distributed systems intertwine with our everyday lives The benefits and current shortcomings of the underpinning technologies are experienced by a wide range of people and their smart devices With the rise of large scale IoT and similar distributed systems cloud bursting technologies and partial outsourcing solutions private entities are encouraged to increase their efficiency and offer unparalleled availability and reliability to their users The Research Anthology on Architectures Frameworks and Integration Strategies for Distributed and Cloud Computing is a vital reference source that provides valuable insight into current and emergent research occurring within the field of distributed computing It also presents architectures and service frameworks to achieve highly integrated distributed systems and solutions to integration and efficient management challenges faced by current and future distributed systems Highlighting a range of topics such as data sharing wireless sensor networks and scalability this multi volume book is ideally designed for system administrators integrators designers developers researchers academicians and students A New System Architecture for Heterogeneous Compute Units Nils Asmussen, 2019 Distributed Systems Architecture Arno Puder, Kay Römer, Frank Pilhofer, 2011-04-18

Middleware is the bridge that connects distributed applications across different physical locations with different hardware platforms network technologies operating systems and programming languages This book describes middleware from two different perspectives from the viewpoint of the systems programmer and from the viewpoint of the applications programmer It focuses on the use of open source solutions for creating middleware and the tools for developing distributed applications The design principles presented are universal and apply to all middleware platforms including CORBA and Web Services The authors have created an open source implementation of CORBA called MICO which is freely available on the web MICO is one of the most successful of all open source projects and is widely used by demanding companies and institutions and has also been adopted by many in the Linux community Provides a comprehensive look at the architecture and design of middlewarethe bridge that connects distributed software applications Includes a complete commercial quality open source middleware system written in C Describes the theory of the middleware standard CORBA as well as how to implement a design using open source techniques Handbook of Heterogeneous Networking ,2018 Here is all the practical hands on information you need to build manage and maintain a heterogeneous computing environment with hardware software and network equipment from a number of different vendors Packed with real world case studies and proven techniques for integrating disparate platforms operating systems and servers Handbook of Heterogeneous Computing is a one stop non nonsense quide that shows you how to port and develop applications in a heterogeneous environment manage desktops data access communications and security in a heterogeneous environment and build distributed heterogeneous systems What is best for your installation Should you standardize on the Windows environment for both production applications and office applications Should you adopt the Windows NT workstation as a standard desktop and use Windows NT as the network operating system Handbook of Heterogeneous Computing details the advantages and disadvantages of these and other approaches The book also explains the arts of porting and developing applications in a heterogeneous environment using Java CGI Perl and other tools how to build interfaces with mainframe legacy systems how to use CORBA to integrate distributed database systems while at the same time managing database gateways and interoperability how to manage interlan switching multicast networking structures SNA LAN integration and all aspects of enterprise networks and how to use Kerberos firewalls PGP RSA public keys and other tools to assure security in heterogeneous environments Heterogeneous computing is here to stay It is therefore up to corporate end users to make competing products fit into their environments efficiently effectively and economically Handbook of Heterogeneous Computing gives you t Provided by publisher <u>Distributed Systems--architecture and Implementation</u> Butler W. Lampson, Manfred Paul, H. J. Siegert, 1983

Architectural Transformations in Network Services and Distributed Systems Andriy Luntovskyy, Josef Spillner, 2017-03-23 With the given work we decided to help not only the readers but ourselves as the professionals who actively involved in the networking branch with understanding the trends that have developed in recent two decades in

distributed systems and networks Important architecture transformations of distributed systems have been examined The A Language for Characterizing Heterogeneous Systems Judith D. examples of new architectural solutions are discussed Schlesinger, Institute for Defense Analyses, 1994 Abstract Currently available taxonomies and models are inadequate for the task of describing complex computer systems and heterogeneous networks of machines We seek a method to describe higher level structural and semantic features of architectures for use in a variety of program transformation and performance analysis tools We present a language adl to describe the architecture of a system or network of systems in such a way as to be used by other software tools **Distributed Component Architecture** G. Sudha Sadasivam, 2007 Market Desc The book is useful for the following readers Undergraduate students in IT and CSE courses This is offered as a core paper in autonomous colleges like PSG College of Technology CSE IT and Coimbatore Institute of Technology BSc CT students as an elective MCA students of Autonomous Colleges like PSG College of Technology Avinashilingam Deemed University and CIT This subject is also offered as a core subject in VI Semester for BE IT students of Anna University Currently there are separate books used as reference for DCOM CORBA and J2EE Hence this book will serve as a single text book for the subject This book can be used as a reference to programmers in Component Technology This book can be used as a reference by students to pursue their research in Grid Technology and Advanced Software Architecture Helpful for research oriented students to do mini project in the area of Component Technology It will be useful for software architects system integrators and internet solution developers and consultants Special Features This book can be used as a reference for the readers who want to get an introduction as well as a detailed knowledge of component technology. It can be used by readers who want to get an in depth knowledge on different Distributed Object Technologies namely RMI CORBA DCOM and EJB It has example programs for each type of technology If possible a CD with examples can be supplied for the readers to execute and see the examples Currently three separate books are used as a reference for CORBA DCOM and EJB No single text book is available for this purpose The proposed book will help to overcome this disadvantage It can be used by software engineers and by academicians About The Book Distributed Software Systems are subject to frequent changes Middleware plays an important role in the development of evolvable systems RMI CORBA DCOM and EJB are mechanisms to create deploy and deal with object oriented components in a distributed environment Java's contribution in distributed computing is to provide platform independent low level code that can be dynamically loaded and linked CORBA provides platform and programming language independence in a heterogeneous distributed environment EJB and DCOM are distributed component models put forth by Sun Microsystems and Microsoft respectively This book brings together the major object models used in distributed computing RMI CORBA DCOM and EJB This book is beneficial for all IT professionals and students This book aims at explaining the features of DCOM CORBA RMI CCM EJB and JavaBeans Programming Models' Support for Heterogeneous Architecture Wei Wu, 2017 Accelerator enhanced computing platforms have drawn a lot of attention due to their massive

peak computational capacity Heterogeneous systems equipped with accelerators such as GPUs have become the most prominent components of High Performance Computing HPC systems Even at the node level the significant heterogeneity of CPU and GPU i e hardware and memory space differences leads to challenges for fully exploiting such complex architectures Extending outside the node scope only escalate such challenges Conventional programming models such as data flow and message passing have been widely adopted in HPC communities When moving towards heterogeneous systems the lack of GPU integration causes such programming models to struggle in handling the heterogeneity of different computing units leading to sub optimal performance and drastic decrease in developer productivity To bridge the gap between underlying heterogeneous architectures and current programming paradigms we propose to extend such programming paradigms with architecture awareness optimization Two programming models are used to demonstrate the impact of heterogeneous architecture awareness The PaRSEC task based runtime an adopter of the data flow model provides opportunities for overlapping communications with computations and minimizing data movements as well as dynamically adapting the work granularity to the capability of the hardware To fulfill the demand of an efficient and portable Message Passing Interface MPI implementation to communicate GPU data a GPU aware design is presented based on the Open MPI infrastructure supporting efficient point to point and collective communications of GPU residential data for both contiguous and non contiguous memory layouts by leveraging GPU network topology and hardware capabilities such as GPUDirect The tight integration of GPU support in a widely used programming environment free the developers from manually move data into out of host memory before after relying on MPI routines for communications allowing them to focus instead on algorithmic optimizations Experimental results have confirmed that supported by such a tight and transparent integration conventional programming models can once again take advantage of the state of the art hardware and exhibit performance at the levels expected by the underlying hardware capabilities Architecture Design and Mapping Flow Development for FPGA-accelerated Heterogeneous Computing Systems Hao Liang, 2017 **Distributed Systems-Architecture and Implementation**,1981 Distributed Systems - Architecture and Implementation D.W. Davies, E. Holler, E.D. Jensen, S.R. Kimbleton, B.W. Lampson, G. LeLann, K.J. Thurber, R.W. Watson, 2014-10-08 Heterogeneous Distributed and Parallel Architectures: Hardware, Software and Design Tools Andy M. Tyrrell, 2000

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