A Study of Cloud Computing Environments for High Performance Applications

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Abstract

High performance applications requires high processing power to compute highly intensive and complex applications for research, engineering, medical and academic projects. In the traditional way, an organization will have to pay very high costs to run an HPC (High Performance computing) application. The organization has to purchase highly expensive hardware for running an HPC application and maintaining it afterwards. The HPC resources on the company premises may not satisfy all the demands of scientific application where resources may not suitable for corresponding requirements. Considering the case of SMEs (small and medium enterprises), an increasing demand is always challenging. Cloud computing is an on-demand, pay-as-you-go model, that offers scalable computing resources, unlimited storage in an instantly available way. In this paper we included requirements of HPC applications in cloud, cluster based HPC applications, types of clusters, Google's HPC Cloud architecture, performance analysis of various HPC cloud vendors and four case studies of HPC applications in cloud.

Keywords: Cloud, HPC, SMEs, EC2, POD Cloud, R-HPC

I. INTRODUCTION

High Performance Computing (HPC) plays an important role in both scientific advancement and economic competitiveness of a nation - making production of scientific and industrial solutions faster, less expensive, and of higher quality. HPC is a key component in many applications: designing vehicles and airplanes; designing high-rise buildings and bridges; discovery of drugs; discovery and extraction of new energy sources like oil and natural gas; weather forecasting; and many more. HPC requires very high processing power to compute largely complex scientific applications. The advantage of pay-as-you-go computing has been an industry goal for many years starting from main frame, cluster and grid computing. Cloud computing takes grid computing to a whole new level by using virtualization to encapsulate an operating system instance and run it in a cloud whenever they need computational resources. In addition cloud storage can also be used independently with operating system instances. Cloud computing also offers unlimited storage and instantly available and scalable computing resources, all at a reasonable metered cost. Cloud also having large data centres which is suitable for data-intensive applications.

II. HPC APPLICATIONS IN CLOUD

With increasing demand for high performance, efficiency, productivity, agility and lower cost, since several years, information communication technology are dramatically changing from static silos with manually managing resources and applications, towards dynamic virtual environments with automated and shared services, i.e. from silo-oriented to service oriented architectures[15]. A "traditional" cloud offers features that are attractive to the general public. These services comprise single, loosely coupled instances (an instance of an OS running in a virtual environment) and storage systems backed by service level agreements (SLAs) that provide the end user guaranteed levels of service. These clouds offer the following features:

- Instant availability – Cloud offers almost instant availability of resources.
- Large capacity – Users can instantly scale the number of applications within the cloud.
- Software choice – Users can design instances to suit their needs from the OS up.
- Virtualized – Instances can be easily moved to and from similar clouds.
- Service-level performance – Users are guaranteed a certain minimal level of performance.

Although these features serve much of the market, HPC users generally have a different set of requirements:

- Close to the "metal" – Many man-years have been invested in optimizing HPC libraries and applications to work closely with the hardware, thus requiring specific OS drivers and hardware support.
- User space communication – HPC user applications often need to bypass the OS kernel and communicate directly with remote user processes.

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Handbook of Research on Cloud-Based STEM Education for Improved Learning Outcomes Chao, Lee,2016-01-18 As technology advances so must our education system Cloud computing serves as an ideal method for e learning thanks to its flexibility affordability and availability Cloud based learning is especially dynamic in STEM education as it can significantly lower the cost of building cumbersome computer labs while fostering engaged learning and collaboration among students The Handbook of Research on Cloud Based STEM Education for Improved Learning Outcomes prepares current and future instructors for exciting breakthroughs in STEM education driven by the advancement of cloud technologies From virtual lab and app construction to information sharing and course material distribution this volume touches on a variety of topics related to the benefits and challenges of adopting cloud technologies in the classroom This book is an invaluable reference for educators technology professionals administrators and education students who wish to become leaders in their fields

Auction Based Resource Provisioning in Cloud Computing Gaurav Baranwal,Dinesh Kumar,Zahid Raza,Deo Prakash Vidyarthi,2018-06-28 The book while introducing readers to the auction mechanism for resource provisioning in cloud computing also endeavors to provide structured literature on the subject Since various models have been proposed it will help readers to formulate the cloud resource provisioning problem using the auction approach The book also discusses challenges for resource provisioning in detail helping to shape future research The target audience for this book includes computer scientists economists industry professionals research scholars and postgraduate students Computer science readers of this book will come to see that economics based method are quite helpful in computer science especially for resource provisioning Readers with a cloud computing background will come to recognize the importance of dynamic pricing the specific benefits of auctions and how to formulate auctions for cloud computing Lastly readers from the economics community will come to understand their role in cloud computing as well as where and how they can contribute **Cloud Computing in Medical Imaging** Ayman El-Baz,Jasjit S. Suri,2023-03-14 Today s healthcare organizations must focus on a lot more than just the health of their clients The infrastructure it takes to support clinical care delivery continues to expand with information technology being one of the most significant contributors to that growth As companies have become more dependent on technology for their clinical administrative and financial functions their IT departments and expenditures have had to scale quickly to keep up However as technology demands have increased so have the options for reliable infrastructure for IT applications and data storage The one that has taken center stage over the past few years is cloud computing Healthcare researchers are moving their efforts to the cloud because they need adequate resources to process store exchange and use large quantities of medical data Cloud Computing in Medical Imaging covers the state of the art techniques for cloud computing in medical imaging healthcare technologies and services The book focuses on Machine learning algorithms for health data security Fog computing in IoT based health care Medical imaging and healthcare

applications using fog IoT networks Diagnostic imaging and associated services Image steganography for medical informatics This book aims to help advance scientific research within the broad field of cloud computing in medical imaging healthcare technologies and services It focuses on major trends and challenges in this area and presents work aimed to identify new techniques and their use in biomedical analysis *Advances in Core Computer Science-Based Technologies* George A. Tsihrintzis,Maria Virvou,2020-06-18 This book introduces readers to some of the most significant advances in core computer science based technologies At the dawn of the 4th Industrial Revolution the field of computer science based technologies is growing continuously and rapidly and is developing both in itself and in terms of its applications in many other disciplines Written by leading experts and consisting of 18 chapters the book is divided into seven parts 1 Computer Science based Technologies in Education 2 Computer Science based Technologies in Risk Assessment and Readiness 3 Computer Science based Technologies in IoT Blockchains and Electronic Money 4 Computer Science based Technologies in Mobile Computing 5 Computer Science based Technologies in Scheduling and Transportation 6 Computer Science based Technologies in Medicine and Biology and 7 Theoretical Advances in Computer Science with Significant Potential Applications in Technology Featuring an extensive list of bibliographic references at the end of each chapter to help readers probe further into the application areas of interest to them this book is intended for professors researchers scientists engineers and students in computer science related disciplines It is also useful for those from other disciplines wanting to become well versed in some of the latest computer science based technologies **Recent Advances in Computer Based Systems, Processes and Applications** Anupama Namburu,Soubhagya Sankar Barpanda,2020-06-14 This was the first conference organized by the school of Computer Science Engineering in VIT AP University campus with the cumulative efforts of all the faculty members The proceedings discusses recent advancements and novel ideas in areas of interest It covers topics such as advances in computer based systems processes and applications Communication and Computing Systems B.M.K. Prasad,Krishna Kant Singh,Neelam Ruhil,Karan Singh,Richard O'Kennedy,2017-02-15 This book is a collection of accepted papers that were presented at the International Conference on Communication and Computing Systems ICCCS 2016 Dronacharya College of Engineering Gurgaon September 9 11 2016 The purpose of the conference was to provide a platform for interaction between scientists from industry academia and other areas of society to discuss the current advancements in the field of communication and computing systems The papers submitted to the proceedings were peer reviewed by 2 3 expert referees This volume contains 5 main subject areas 1 Signal and Image Processing 2 Communication Computer Networks 3 Soft Computing Intelligent System Machine Vision and Artificial Neural Network 4 VLSI Embedded System 5 Software Engineering and Emerging Technologies Advanced Informatics for Computing Research Ashish Kumar Luhach,Dharm Singh,Pao-Ann Hsiung,Kamarul Bin Ghazali Hawari,Pawan Lingras,Pradeep Kumar Singh,2018-11-28 This two volume set CCIS 955 and CCIS 956 constitutes the refereed proceedings of the Second International Conference on Advanced

Informatics for Computing Research ICAICR 2018 held in Shimla India in July 2018 The 122 revised full papers presented were carefully reviewed and selected from 427 submissions The papers are organized in topical sections on computing methodologies hardware information systems networks security and privacy computing methodologies *Cybersecurity in Cloud Computing* Akula Achari,2025-01-23 Cybersecurity in Cloud Computing delves into the security challenges and solutions in the rapidly evolving world of cloud technology We explore key concepts such as data protection threat detection and risk management within cloud environments The book highlights how cloud services can enhance scalability and flexibility while also presenting new security risks that need to be addressed Readers will gain insights into the latest cybersecurity practices including encryption methods identity management and multi factor authentication We also discuss the importance of developing a comprehensive security policy to safeguard cloud infrastructure Whether you are an IT professional or a business owner this book equips you with the tools to secure your digital assets and maintain data integrity in the cloud Context-Aware Cloud Service Selection Model for Mobile Cloud Computing Environments Xu Wu, Mobile cloud computing MCC has attracted extensive attention in recent years With the prevalence of MCC how to select trustworthy and high quality mobile cloud services becomes one of the most urgent problems *Proceedings, 2014 IEEE 7th International Conference on Cloud Computing* Institute of Electrical and Electronics Engineers,2014 **IEEE Third Symposium on Network Cloud Computing and Applications** IEEE Computer Society,Institute of Electrical and Electronics Engineers,2014 Graphics Interface 2014 Paul G. Kry,Andrea Bunt,2014-05-06 This book is the proceedings of the 40th annual Graphics Interface conference the oldest continuously scheduled conference in the field The book includes high quality papers on recent advances in interactive systems human computer interaction and graphics from around the world It covers the following topics shading and rendering geometric modeling and meshing image based rendering image synthesis and realism computer animation real time rendering non photorealistic rendering interaction techniques human interface devices augmented reality data and information visualization mobile computing haptic and tangible interfaces and perception 2014 IEEE 3rd International Conference on Cloud Computing and Intelligence Systems (CCIS) IEEE Staff,2014-11-27 Research and development on cloud computing and intelligent systems have been carried out in last few years and some of them have been successfully deployed and used in many fields This year the conference aims to address Challenges for cloud computing and intelligent technology The conference will feature a comprehensive technical program including a number of keynote speeches and session discussions **Standard Handbook for Electrical Engineers, Seventeenth Edition** Surya Santoso,H. Wayne Beaty,2017-11-24 Up to date coverage of every facet of electric power in a single volume This fully revised industry standard resource offers practical details on every aspect of electric power engineering The book contains in depth discussions from more than 100 internationally recognized experts Generation transmission distribution operation system protection and switchgear are thoroughly explained Standard Handbook for

Electrical Engineers Seventeenth Edition features brand new sections on measurement and instrumentation interconnected power grids smart grids and microgrids wind power solar and photovoltaic power generation electric machines and transformers power system analysis operations stability and protection and the electricity market Coverage includes Units symbols constants definitions and conversion factors Measurement and instrumentation Properties of materials Interconnected power grids AC and DC power transmission Power distribution Smart grids and microgrids Wind power generation Solar power generation and energy storage Substations and switch gear Power transformers generators motors and drives Power electronics Power system analysis operations stability and protection Electricity markets Power quality and reliability Lightning and overvoltage protection Computer applications in the electric power industry Standards in electrotechnology telecommunications and IT   Computers and Information Processing Technologies I Prasad Yarlagadda,Yun Hae Kim,2014-06-10 Selected peer reviewed papers from the International Conference on Computers and Information Processing Technologies ICCIPT 2014 April 23 24 2014 Shanghai China   Advances in Mechatronics, Robotics and Automation II Prasad Yarlagadda,2014-04-04 Selected peer reviewed papers from the 2014 2nd International Conference on Mechatronics Robotics and Automation ICMRA 2014 March 8 9 2014 Zhuhai China   **Cloud Computing** Victor C.M. Leung,Roy Xiaorong Lai,Min Chen,Jiafu Wan,2015-03-07 This book constitutes the thoroughly refereed post conference proceedings of the 5th International Conference on Cloud Computing CloudComp 2014 held in Guilin China in October 2014 The 25 revised full papers were carefully reviewed and selected from 72 submissions and cover topics such as mobile cloud computing services applications IoT on cloud architectures and big data cloud assisted pervasive computing and services management and virtualization for cloud cloud security   **Enabling Technologies Development Grant Program** Therese Peffer,Gaymond Yee,Niall J. Mateer,California Institute for Energy and Environment,2015   **Sustainability of Higher Education** Rosni Bakar,Aziah Ismail,2018   **Edge Intelligence in the Making** Sen Lin,Zhi Zhou,Zhaofeng Zhang,Xu Chen,Junshan Zhang,2020-10-21 With the explosive growth of mobile computing and Internet of Things IoT applications as exemplified by AR VR smart city and video audio surveillance billions of mobile and IoT devices are being connected to the Internet generating zillions of bytes of data at the network edge Driven by this trend there is an urgent need to push the frontiers of artificial intelligence AI to the network edge to fully unleash the potential of IoT big data Indeed the marriage of edge computing and AI has resulted in innovative solutions namely edge intelligence or edge AI Nevertheless research and practice on this emerging inter disciplinary field is still in its infancy stage To facilitate the dissemination of the recent advances in edge intelligence in both academia and industry this book conducts a comprehensive and detailed survey of the recent research efforts and also showcases the authors own research progress on edge intelligence Specifically the book first reviews the background and present motivation for AI running at the network edge Next it provides an overview of the overarching architectures frameworks and emerging key technologies for deep learning models toward training inference

at the network edge To illustrate the research problems for edge intelligence the book also showcases four of the authors own research projects on edge intelligence ranging from rigorous theoretical analysis to studies based on realistic implementation Finally it discusses the applications marketplace and future research opportunities of edge intelligence This emerging interdisciplinary field offers many open problems and yet also tremendous opportunities and this book only touches the tip of iceberg Hopefully this book will elicit escalating attention stimulate fruitful discussions and open new directions on edge intelligence

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