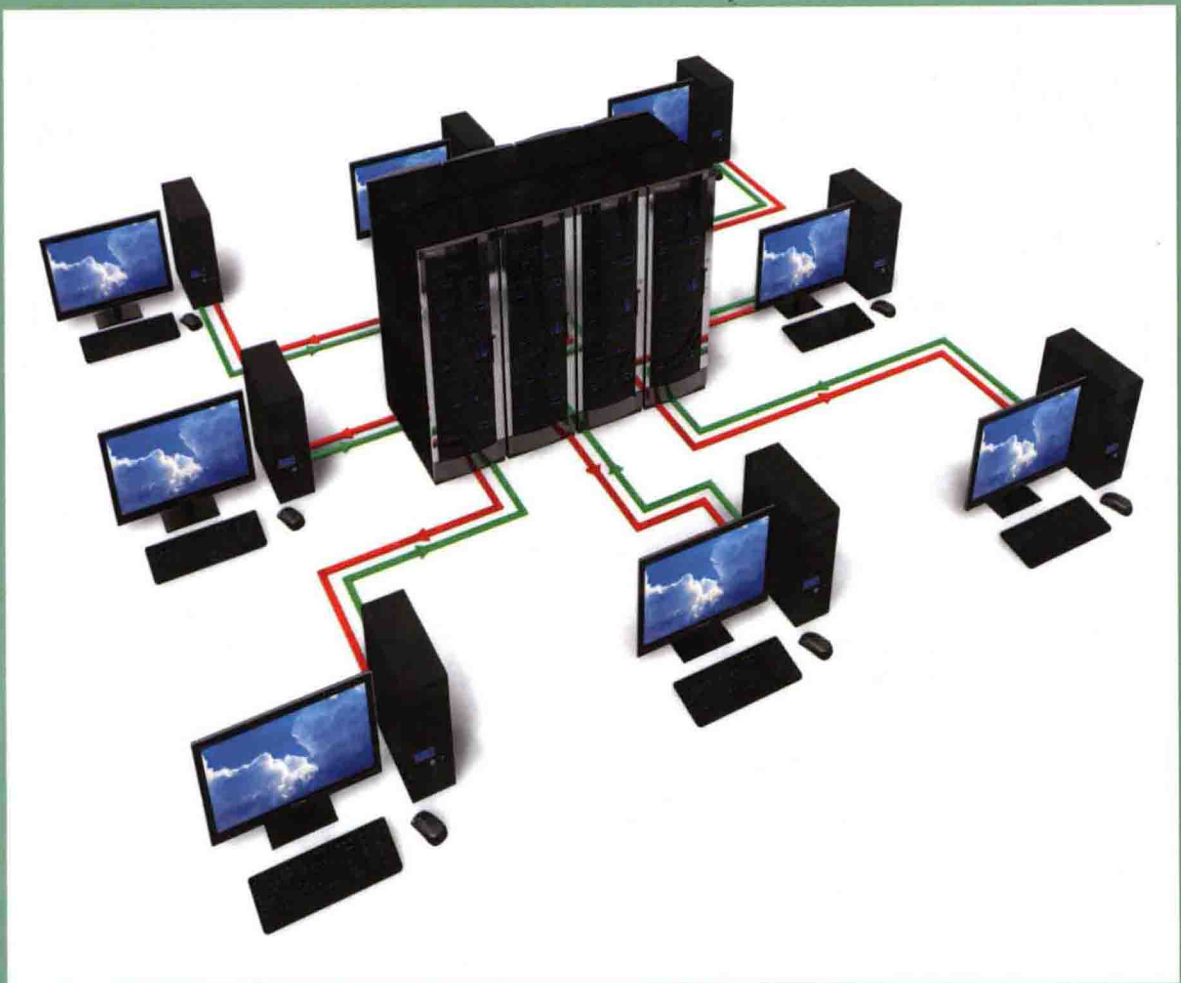


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Cloud Computing Advancements in Design, Implementation, and Technologies



Shadi Aljawarneh

Cloud Computing Advancements in Design, Implementation, and Technologies

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Isra University, Jordan



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Preface

*“Do not worry about your difficulties in Mathematics.
I can assure you mine are still greater.” Albert Einstein*

This publication summarizes the 2011 volume contents of *International Journal of Cloud Applications and Computing* (IJCAC) that addresses current trends in Cloud Computing, such as Cloud services, applications, and technologies. To illustrate the role of applications and services in the growth of Cloud computing industries, a number of examples focusing on the learning, government, and security are used.

This book is intended for researchers and practitioners who are interested in issues that arise from using technologies of cloud computing advancements. In addition, this book is also targeted to anyone who wants to learn more about the cloud computing advancements in design and implementation. Cloud computing has become a hot topic in recent years and people at varying levels in any organization need to understand cloud computing in different ways.

OVERVIEW OF THE BOOK

This book presents the current state of cloud computing advancements in design, implementation, and technology. Issues in the field and their influence in the science of cloud computing and applications are summarized as follows.

Issue 1

Junaid Arshad *et al.* present efforts to address one of the significant issues with respect to security of Clouds i.e. intrusion detection and severity analysis. An abstract model for integrated intrusion detection and severity analysis for Clouds is proposed to facilitate minimal intrusion response time while preserving the overall security of the Cloud infrastructures.

Ismael Solis Moreno *et al.* argue the importance of energy-efficient mechanisms within cloud data centers and remark on the significance of the “energy-performance” relationship in boosting the adoption of these mechanisms in real scenarios. The chapter provides an analysis of the current approaches and an outline of key opportunities that need to be addressed to improve the “energy-performance” relationship in this promising model.

Luis M. Vaquero *et al.* aim to make the reader’s acquaintance with this long needed problem in distributed systems: user-oriented service-level scalability. Scalability issues are analyzed from the Infrastructure as a Service (IaaS) and the Platform as a Service (PaaS) point of view, as they deal with different functions and abstraction levels.

Zhiwei Xu, *et al.* present five research directions for optimizing Hadoop-improving performance, utilization, power efficiency, availability, and different consistency constraints. The survey covers both back-end analysis and customer-facing workloads.

Hong Cai *et al.* describe the authors' practice of developing and deploying multi-tenant technologies. This paper targets a technology that could quickly enable existing Java EE (Enterprise Edition) applications to be multi-tenancy enabled thus having the benefit of quick time to market.

Issue 2

P. Sasikala examines and discusses the concept of Cloud Computing from the perspectives of diverse technologists, cloud standards, services available today, the status of cloud particularly in higher education, and future implications.

Roland Kübert and Gregory Katsaros present the architectural approach as well as the technical solution for applying elastic web hosting onto a private cloud infrastructure using only free software. Through several available software applications and tools, anyone can build their own private cloud on top of a local infrastructure and benefit from the dynamicity and scalability provided by the cloud approach.

Louay Karadsheh *et al.* review the transition from traditional computing to cloud computing and the benefit for businesses, cloud computing architecture, cloud computing services classification, and deployment models. They also discuss the security policies and types of internal risks that a small business might encounter implementing cloud computing technologies.

Victor Chang *et al.* demonstrate portability, speed, accuracy, and reliability of applications in the clouds, while demonstrating portability for Financial Software as a Service (FSaaS) and the Cloud Computing Business Framework (CCBF).

Shadi Aljawarneh discusses this security issue. Furthermore, a vision and strategy is proposed to mitigate or avoid the security threats in the Cloud. This broad vision is based on software engineering principles to secure the Cloud applications and services.

Issue 3

Kamal Dahbur and others explain Cloud Computing and many of its related concepts, highlighting and categorizing many of the security issues introduced by the Cloud.

S.K. Maharana and others develop an efficient, faster, and secure simulation technique by leveraging control volume method (CVM) of linearization of relevant equations for the study.

Kamal Dahbur and others highlight the challenges introduced by anti-forensics, explore the various CAF mechanisms, tools, and techniques, provide a coherent classification for them, and discuss their effectiveness thoroughly. Moreover, this paper also highlights the challenges seen in implementing effective countermeasures against these techniques. Finally, a set of recommendations is presented with future research opportunities.

R.Jeyarani and others focus on green computing by introducing Power-Aware Meta Scheduler, which provides the right fit infrastructure for launching virtual machines onto a host. The experimental results show that the appropriate usage of different power saving states guarantees significant energy conservation in handling stochastic nature of workload without compromising the performance, both when the data center is in low as well as moderate utilization.

Promise Mvelase and others focus on the implementation of virtual enterprises (VE), to enable SMMEs to respond quickly to customers' demands and market opportunities. The virtual enterprise

model is based on the ability to create temporary co-operations and to realize the value of a short term business opportunity that the partners cannot (or can, but only to a lesser extent) capture on their own.

Issue 4

P. Sasikala discusses the various architectural strategies for clean and green cloud computing. The chapter analyzes the various environments, infrastructures, and resources available in cloud computing.

Jeffrey Chang attempts to develop a framework for analyzing the likely impact of cloud computing on local government and suggested an agenda for research in this emerging area.

P. Sasikala reviews the development processes of public communication network and computing along with some new concepts for cloud computing. So the following works should be done pressingly: (1) turn the computing resources into network elements, form a optimal architecture of network, platform, terminal, and service; (2) formulate the compatible and interoperable technical standard of computing resources; (3) integrate the research, manufacture, network constructing, application development, and service supply to build a more open business model.

Ghalem Belalem *et al.* propose a fault tolerant architecture to Cloud Computing that uses an adaptive checkpoint mechanism to assure that a task running can correctly finish in spite of faults in the nodes in which it is running.

FUTURE TRENDS IN CLOUD COMPUTING ADVANCEMENTS IN DESIGN, IMPLEMENTATION, AND TECHNOLOGIES

Cloud computing analysts have stated “the global market for cloud computing will grow from \$40.7 billion in 2011 to more than \$241 billion in 2020” (Forrester Research, 2011).

It should be noted on *mobility*: “Over 80% of the Fortune 100 is deploying or piloting tablets with sales expected to increase by 123%” (Ellis, 2012). Whereas, as regards *storage*: “Nearly 40% increase expected by 2012 in backing up to/storing data in the cloud. Each day, AWS adds the equivalent server capacity to power Amazon when it was a global, \$2.76B enterprise (circa 2000)” (Varia, 2009).

According to Economist Intelligence Survey (October 2011), the cloud landscape is evolving. A few points from 2010:

- (i) Peak of market hype on cloud computing -- driven by cost savings and IT efficiency gains.
- (ii) Security, availability and vendor lock-in are primary concerns for CIOs.
- (iii) Sandbox/ trial implementations of non-critical applications emerge: Testing enterprise-readiness.

By 2015:

- (i) enterprises will expand the focus of cloud computing as a driver of business innovation.
- (ii) Cloud computing will play a significant role in shaping client value propositions.
- (iii) Enterprises will look at the cloud to drive innovation across the eco-system.
- (iv) The Cloud will be increasingly used to drive collaboration and reduce business complexity.

The book looks at each trend and also highlights future research topics. For example, to take advantage of industries, practitioners and governments need to further develop Cloud applications and services

and continue to invest in research and development. Metrics are needed to measure the impacts of these investments. How should organizations build trust to achieve collaborative applications and services? What are the legal implications of collaborative Cloud-based commerce, learning, and government? Note that the next generation Cloud provisioning models rely on advanced monitoring and automatic scaling decision capabilities to ensure quality of service (QoS), security, and economic sustainability.

Most papers in this book express concern over the customer's fears regarding the use of cloud applications. How to calm these fears in the future is also addressed. In this book, most authors focus on some issues in Cloud computing design, technologies, and implementation. For instance, although the security and availability guarantees from reputable organizations, such as Amazon and Microsoft, customers are still worried about their data over the Cloud. Do the keys of the encrypted data encrypt or only place it somewhere on the host machines? The owner of the data will be worried because his or her data and software are not under his or her control. In addition, the data owner may not recognize where the data is geographically located at any particular time. There is still a question mark over how data will be more secure if the owner does not control its data and software. To minimize this risk, customers must be given the opportunity to assess the trustworthiness of the Cloud. Another question is what happens if someone stops the company's servers for work or if the servers are faced with major problems that prevent them from working? What follows now are a few mentions of some reasons for why the customer's fears are increased.

Many phone customers might be shocked to find that phones may rely exclusively on the company's servers to handle and keep their data. The question is: what happens if I stop the company's servers for work or if the servers face major problems that prevent them from working? The truth is that, regardless of the capacity and capabilities of the company that manages these servers, the potential collapse of the system could take place everywhere and at any moment, and then this meltdown could happen. Thus, the second question, could cloud computing fail? To overcome this big question, another chapter discusses this as part of a future work.

Reputable companies attempted to mitigate customer fears by confirming that the cloud model is secure, the cloud services are protected, the data centers and hosted servers are encrypted, the communication channel between the customer and the cloud resources are secured, and that it is protected from any kind of attack. However, attackers claim that cloud resources are penetrated much more easily than non-cloud environments. For instance, Sony stated that the customers' credit card data was secure, but the attackers claimed that the customers' credit card data was sold online. Both parties make claims about the truth, but without information, all we can do is make choices about what to believe. If Sony is telling the truth about encrypting the data, it seems that the level of encryption was not sufficient (Bradley, 2011).

One of the effective solutions for security issues in Cloud computing is the way Amazon used the Cloud services for introducing a number of web services for customers. Amazon constructed the Amazon Web Services (AWS) platform to secure access for web services. The AWS platform introduces protection against traditional security issues in the Cloud network (Amazon Web Services, 2011).

Furthermore, Amazon only offers restricted Datacenter access and information to people who have a legal business need for these privileges. If the business need for these privileges is revoked, then the access is stopped, even if employees continue to be employed by Amazon or Amazon Web Services (Amazon Web Services, 2011).

In this publication, the authors proposed a number of perspectives to calm customer's fears against Cloud concerns.

First perspective: Preventing details about how the model-driven security policies should be enforced, this book recommends that governments keep their information assurance architectures secure and confidential. For instance, the UK Cabinet office published a number of Government Cloud documents, but did not publish the Information Assurance documents. The contributors of this book do not agree with the perspective of Ulrich Lang (Co-Founder & CEO at ObjectSecurity, USA) who stated Government Cloud documents should publish the Information Assurance documents for the following reasons:

- There is no need for creating a public cloud if the documents are confidential, and creating public Government Cloud will not make sense.
- Building public or even private Government Cloud would cost billions and make a lot of under-serving time-servers (2011).

Second perspective: To date, financial organizations are not willing to adopt public cloud because it will be risky, as explained in the above sections. It is possible to use the private cloud in financial organizations. Some authors discuss the following questions:

- Are financial organizations willing to embrace cloud computing?
- What will be their preference - Private or Public Cloud?

A summary of the key points of this book:

- Importance of the transition from traditional to Cloud in the intended sense.
- Developing strategies and solutions to the problem of research by linking traditional relationships and concepts that facilitate access to information. For example:
 - Architectural Design for Cloud applications and services
 - How to implement the Cloud applications and services.
 - Cloud computing for large scale applications
 - Cloud technologies for P2P, services, agents, grids and middleware
 - Cloud technologies for software and systems engineering
 - Cloud for E-government
 - Databases, IR and AI technologies for Cloud
 - Social networks and processes on the Cloud
 - Representing and reasoning about trust, privacy, and security
 - Cloud computing techniques and approaches
 - Frameworks for developing Web applications
 - Security issues for Web applications
 - Scalability issues and techniques
 - Applications that illustrate interesting new features or implementation techniques
 - Performance measurements of Cloud applications
 - M-commerce applications, issues, and security

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Shadi Aljawarneh
Isra University, Jordan

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Junaid Arshad, University of Leeds, UK

Paul Townend, University of Leeds, UK

Jie Xu, University of Leeds, UK

Cloud computing is an emerging computing paradigm which introduces novel opportunities to establish large scale, flexible computing infrastructures. However, security underpins extensive adoption of Cloud computing. This paper presents efforts to address one of the significant issues with respect to security of Clouds i.e. intrusion detection and severity analysis. An abstract model for integrated intrusion detection and severity analysis for Clouds is proposed to facilitate minimal intrusion response time while preserving the overall security of the Cloud infrastructures. In order to assess the effectiveness of the proposed model, detailed architectural evaluation using Architectural Trade-off Analysis Model (ATAM) is used. A set of recommendations which can be used as a set of best practice guidelines while implementing the proposed architecture is discussed.

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Energy-Efficiency in Cloud Computing Environments: Towards Energy Savings without Performance Degradation	18
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Ismael Solis Moreno, University of Leeds, UK

Jie Xu, University of Leeds, UK

Due to all the pollutants generated during its production and the steady increases in its rates, energy consumption is causing serious environmental and economic problems. In this context, the growing use and adoption of ICTs is being highlighted not only as one of the principal problem sources but also as one of the principal areas that could help in the problem's reduction. Cloud computing is an emerging model for distributed utility computing and is being considered as an attractive opportunity for saving energy through central management of computational resources. To be successful, the design of energy-efficient mechanisms must start playing a mayor role. This paper argues the importance of energy-efficient mechanisms within cloud data centers and remarks on the significance of the "energy-performance" relationship in boosting the adoption of these mechanisms in real scenarios. It provides an analysis of the current approaches and the outline of key opportunities that need to be addressed to improve the "energy-performance" relationship in this promising model.

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The Challenge of Service Level Scalability for the Cloud	37
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Luis M. Vaquero, Telefónica Investigación y Desarrollo, Spain

Juan Cáceres, Telefónica, Spain

Daniel Morán, Universidad Nacional de Educación a Distancia, Spain

This paper presents a brief overview of the available literature on distributed systems scalability that serves as a justification for presenting some of the most prominent challenges that current Cloud systems need to face in order to deliver their pledged easy-to-use scalability. Through illustrative comparisons and examples, this paper aims to make the reader's acquaintance with this long needed problem in distributed systems: user-oriented service-level scalability. Scalability issues are analyzed from the Infrastructure as a Service (IaaS) and the Platform as a Service (PaaS) point of view, as they deal with different functions and abstraction levels. Next generation Cloud provisioning models rely on advanced monitoring and automatic scaling decision capabilities to ensure quality of service (QoS), security and economic sustainability.

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Zhiwei Xu, Chinese Academy of Sciences, China

Bo Yan, Chinese Academy of Sciences, China

Yongqiang Zou, Tencent Research, China

As a main subfield of cloud computing applications, internet services require large-scale data computing. Their workloads can be divided into two classes: customer-facing query-processing interactive tasks that serve hundreds of millions of users within a short response time and backend data analysis batch tasks that involve petabytes of data. Hadoop, an open source software suite, is used by many Internet services as the main data computing platform. Hadoop is also used by academia as a research platform and an optimization target. This paper presents five research directions for optimizing Hadoop; improving performance, utilization, power efficiency, availability, and different consistency constraints. The survey covers both backend analysis and customer-facing workloads. A total of 15 innovative techniques and systems are analyzed and compared, focusing on main research issues, innovative techniques, and optimized results.

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Hong Cai, IBM China Software Development Lab, China

Berthold Reinwald, IBM Almaden Research Center, USA

Ning Wang, IBM China Software Development Lab, China

Chang Jie Guo, IBM China Research Lab, China

SaaS (Software as a Service) provides new business opportunities for application providers to serve more customers in a scalable and cost-effective way. SaaS also raises new challenges and one of them is multi-tenancy. Multi-tenancy is the requirement of deploying only one shared application to serve multiple customers (i.e. tenant) instead of deploying one dedicated application for each customer. This paper describes the authors' practice of developing and deploying multi-tenant technologies. This paper targets a technology that could quickly enable existing Java EE (Enterprise Edition) applications to be multi-tenancy enabled thus having the benefit of quick time to market. This paper describes the overall framework of multi-tenant SaaS platform, how to migrate an existing Java EE application, how to provision the multi-tenant application, and how to onboard the tenants. The paper also shows experiments

which compare the economics of multi-tenant SaaS deployment versus traditional application deployment (one application for one tenant) with precise data.

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Cloud Computing in Higher Education: Opportunities and Issues..... 83

*P. Sasikala, Makhanlal Chaturvedi National University of Journalism and Communication,
India*

Cloud Computing promises novel and valuable capabilities for computer users and is explored in all possible areas of information technology dependant fields. However, the literature suffers from hype and divergent definitions and viewpoints. Cloud powered higher education can gain significant flexibility and agility. Higher education policy makers must assume activist roles in the shift towards cloud computing. Classroom experiences show it is a better tool for teaching and collaboration. As it is an emerging service technology, there is a need for standardization of services and customized implementation. Its evolution can change the facets of rural education. It is important as a possible means of driving down the capital and total costs of IT. This paper examines and discusses the concept of Cloud Computing from the perspectives of diverse technologists, cloud standards, services available today, the status of cloud particularly in higher education, and future implications.

Chapter 7

Using Free Software for Elastic Web Hosting on a Private Cloud 97

*Roland Kübert, University of Stuttgart, Germany
Gregory Katsaros, University of Stuttgart, Germany*

Even though public cloud providers already exist and offer computing and storage services, cloud computing is still a buzzword for scientists in various fields such as engineering, finance, social sciences, etc. These technologies are currently mature enough to leave the experimental laboratory in order to be used in real-life scenarios. To this end, the authors consider that the prime example use case of cloud computing is a web hosting service. This paper presents the architectural approach as well as the technical solution for applying elastic web hosting onto a private cloud infrastructure using only free software. Through several available software applications and tools, anyone can build their own private cloud on top of a local infrastructure and benefit from the dynamicity and scalability provided by the cloud approach.

Chapter 8

Applying Security Policies in Small Business Utilizing Cloud Computing Technologies..... 112

*Louay Karadsheh, ECPI University, USA
Samer Alhawari, Applied Science Private University, Jordan*

Over a decade ago, cloud computing became an important topic for small and large businesses alike. The new concept promises scalability, security, cost reduction, portability, and availability. While addressing this issue over the past several years, there have been intensive discussions about the importance of cloud computing technologies. Therefore, this paper reviews the transition from traditional computing to cloud computing and the benefit for businesses, cloud computing architecture, cloud computing services classification, and deployment models. Furthermore, this paper discusses the security policies and types of internal risks that a small business might encounter implementing cloud computing technologies. It addresses initiatives towards employing certain types of security policies in small businesses implementing cloud computing technologies to encourage small business to migrate to cloud computing by portraying what is needed to secure their infrastructure using traditional security policies without the complexity used in large corporations.