Mountain Plains Journal of Business and Technology

Volume 21
Issue 2 *Focus on Technology*

Article 7

Date Published: December 2020

Looking Towards The Sky: Cloud Computing from a Conceptual to an IT Industry Game Changer

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LOOKING TOWARD THE SKY: CLOUD COMPUTING FROM A CONCEPTUAL TO AN IT INDUSTRY GAME CHANGER[1]

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ABSTRACT

Cloud computing is highly embraced and identified as one of the major innovations in the computing field in recent years. The main goals of this article, which is based on literature reviews and personal work experience, are to present an overview of the conceptual idea of cloud computing, the cloud-computing delivery paradigms, common roles in cloud computing, the most mentioned advantages of adopting cloud computing in enterprise environments, the main criticisms facing cloud computing, and recommendations for ensuring the success of cloud computing implementation and adoption. This will inform and educate business managers, IT managers, and higher education decision-makers regarding cloud-computing adoption and implementation on how to do so more successfully based on secure, flexible and scalable, reliable, and cost-effective cloud-computing services.

Keywords: Cloud computing, cloud-computing services, cloud-based services, business requirements, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Storage as a Service (STaaS), Big Data as a Service (BDaaS), virtualization, service level agreement (SLA), cost-effectiveness, flexibility, scalability, interoperability, implementation, adoption

INTRODUCTION

The Conceptual Idea of Cloud Computing

The idea of cloud computing is not new or complicated. What is new is the growth and the advanced maturity of cloud computing by increasing the services' capabilities and efficiencies. The technology leaders (like Amazon, Google, Microsoft, and Oracle) realized the potential in combining and sharing computing resources, which gave cloud computing momentum to be widely used in all sectors (private, commercial, public-sector, government, and education). Cloud computing has exceptionally affected the fulfillment of end-to-end business requirements to deliver greater value, enabled by ubiquitous cloud-based computing resources.

The conceptual idea of computing in the cloud can be traced back to the origins of utility computing. Computer scientist and the father of the Artificial Intelligence (AI) discipline John McCarthy proposed the idea of utility computing in 1961. A new important industry was revolutionized out of it, which is now known as cloud computing. In the late 1990s, Salesforce.com pioneered the notion of bringing remotely provisioned services into the enterprise, and in 2002, Amazon launched the Amazon Web Services (AWS) paradigm. In 2006, the term cloud computing emerged in the commercial arena that enabled cloud consumers to lease computing capacity and processing power to run their enterprise applications. McCarthy's prediction of cloud computing came true forty-five years later as a pivotal computing paradigm (Wessels, 2012), much like phone

[1] Submitted: 9 Jan 2020; Revised: 3 Mar 2020; Accepted: 30 Mar 2020

and electricity grid as a public utility. Cloud computing is currently used across the board, with 90% of enterprises using some kind of cloud-based services (Saini, Jyoti, & Kaur, 2017).

Cloud computing is a computing paradigm that delivers infrastructure and software resources over the network/internet to meet on-demand services (Saleem, 2016). Based on the delivered cloud-computing services, the cloud delivery model can take different forms: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Storage as a Service (STaaS), Big Data as a Service (BDaaS), and more. These services promise flexibility, scalability, reliability, high availability, disaster-safety, and cost-effectiveness, and they are a proven delivery platform for business information services over the internet (Wheeler & Waggener, 2009). Therefore, cloud consumers and/or organizations have the ability to outsource on premise infrastructure and software capabilities on a large scale and focus on their core competencies of a business by adapting how to operate in a cloud-computing environment.

Cloud computing has three essential characteristics: elasticity, pay-as-you-go pricing, and virtualization (Wessels, 2012). Elasticity means cloud consumers can acquire and release the leased computing services as needed to support their computing business requirements; they pay for the computing services they are using to support their businesses. Pay-as-you-go pricing means the cloud users pay minimal up-front costs to acquire the cloud-computing services to run and support their applications that satisfy their business requirements; however, the cloud user has no ownership of the cloud-computing resources. The main characteristic of cloud computing is virtualization, which enables the cloud service providers to optimize the use of available physical resources to their ideal capacities. The technology leaders in cloud computing, such as Google, Microsoft, Oracle, and Amazon have built massive data centers in the United States, as well as in Asia and Europe. These data centers are hosting the best available blades technology infrastructure, generators for power-outage, uninterruptable power supplies (UPS) systems, cooling systems, high-bandwidth communications, and highly interconnected networking architectures to support and enable 24/7 high availability and reliability services (Kurose & Ross, 2017).

COMMON ROLES IN CLOUD COMPUTING

The most common roles in cloud computing are introduced by Erl, Mahmood, and Puttini (2013) in relation to cloud-based activities. The cloud-computing provider is the organization that provides cloud-based resources/services, and they are responsible for making cloud-computing services available to their cloud consumers according to the service level agreement (SLA). Cloud providers may own or can be the resellers of cloud-computing services. The cloud-computing consumer is the consumer and/or organization that has a formal contract with the cloud-computing provider to use the proper services made available by the provider to the consumer based on the SLA; it is vital for cloud-computing consumers to be well educated and knowledgeable of the proper cloud-computing services. The cloud-computing owner is the person or vendor that legally owns the cloud-computing services. The cloud-computing administrator is the person or organization responsible for administering cloud-based resources and services. A cloud-computing auditor is usually a third-party entity that conducts independent evaluations and assessments of the cloud service environments based on auditing the provided services related to security, privacy and encryption, data integrity and availability, and performance, according to the signed SLA (Elifoglu, Guzey, & Tasseven, 2014). A cloud-computing broker is an entity that assumes the responsibilities of managing and negotiating the usage of cloud-computing services between cloud-computing providers and cloud-computing consumers. A cloud-computing carrier is the

party responsible for providing network connectivity between cloud-computing providers and cloud-computing consumers.

THE CLOUD-COMPUTING DELIVERY PARADIGMS

The common cloud-computing delivery models are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Storage as a Service (STaaS), Big Data as a Service (BDaaS), and more. Infrastructure as a Service (IaaS) is the most basic cloud service offering related to computing infrastructure (Saini, Jyoti, & Kaur, 2017); in this model, the cloud service providers provide the cloud consumers and/or organizations with the on-demand virtual servers and other virtual devices, which allows the consumers and/or companies to install, configure, and maintain their own operating environment using their own software licenses and applications. This service model would eliminate the need to purchase and maintain the entire infrastructure, including the hardware in their on-premise data center. Thus, the cloud consumer is paying for the virtual hardware services they need. Oracle, Google, Amazon Web Service, and Microsoft Azure provide IaaS.

The starting up entrepreneur application development companies commonly use platform as a Service (PaaS), which allows developers to build applications and services on cloud-based environments (Saini, Jyoti, & Kaur, 2017). The cloud service providers provide the cloud consumers and/or organizations with platform as a service. The virtual hardware infrastructure, along with the operating system software, relational database management system (RDBMS), and programming environment is provided to the cloud consumers to run or develop their applications. The cloud user is responsible for installing, configuring, and maintaining the full software development stack. Since 2006, the trend of applications development has been shifting from hardware-based operating systems into cloud-based services (Cusumano, 2019). Oracle, Google, Amazon Web Service, and Microsoft Azure provide PaaS.

Software as a Service (SaaS) is the most common cloud service model used by cloud consumers and/or organizations. In this model, the consumers are directly interacting and utilizing the applications on SaaS. The cloud user leases access to software. The cloud server provider is responsible for keeping the full-stack software up-to-date and well maintained. Software as a Service (SaaS) allows the users to run and use applications without the high cost and hassle of installing the application software on their on-premise infrastructure. In addition, the cloud consumer eliminates the cost of maintenance and upgrade, software licensing, and annual customer support fee (Saini, Jyoti, & Kaur, 2017). Oracle, Google, Amazon Web Service, and Microsoft Azure provide SaaS.

Storage as a Service (STaaS) is a cloud service model in which the cloud service providers provide the cloud consumers and/or organizations with storage infrastructure to store their data and access it from the internet at any time and from anywhere (Rizvi & Ramesh, 2019) and with the proper software to access and retrieve their stored data. The cloud consumers and/or organizations may use this model for a convenient methodology for managing backup and savings costs (Attaran & Woods, 2019) by eliminating on-premise hardware, tapes, and physical space at their data center. Google, Amazon Web Service, and Microsoft Azure provide STaaS.

Big Data as a Service (BDaaS) is a cloud service model of employing a large volume of unstructured data and/or complex data set at a high capacity so as to process it rapidly and efficiently, and to derive meaningful results from it and to provide a lot of value for cloud

consumers (Cuddeford-Jones, 2015). Thus, proper use of big data can drive decisions based on big data analysis insights to drive business growth and to gain a competitive advantage (Preimesberger, 2018). Google, Amazon Web Service, and Microsoft Azure provide BDaaS.

ADVANTAGES OF ADOPTING CLOUD COMPUTING

The main three benefits of cloud computing are agility, enhanced reliability and security, and cost-effectiveness (Chang, Ramachandran, Yao, Kuo, & Li, 2016). Agility means the cloud users can acquire and release as needed the cloud-computing resources based on their business requirements or business cycles. Thus, there is a great deal of flexibility in provisioning cloud-computing services to satisfy the cloud users' business workloads (McCarthy & Hill, 2011). Enhanced reliability and security means the cloud service providers consider cloud-computing services' reliability and security as their top priority and primary function toward their cloud users. Thus, system maintenance and security patching is one of the top responsibilities of their technical staffs who are experts in keeping the system well-maintained and up-to-date on security patching; therefore, the cloud user can expect a reliable, robust, and secure system. Maresova, Sobeslav, and Krejcar (2017) conducted a study by using cost-benefit analysis (CBA) for cloud computing to evaluate costs and benefits of using cloud computing and found it significantly effective. Cost-effectiveness means the cloud users can avoid a high capital investment required to build computing infrastructure by repurposing it to other core business needs instead, which allows the cloud users to operate on low operating costs and save on IT staff costs. Thus, using cloud-computing services can bring dramatic gains for cloud consumers.

THE MAIN CRITICISMS FACING CLOUD COMPUTING

The main three criticisms (risks and challenges) facing cloud computing are dependability, vendor lock-in, and inter-cloud integration. Dependability is a combination of reliability, availability, and security (RAS). Cloud-computing reliability to a consumer means that cloud-computing services are available as needed based on the SLA (Manuel, 2015). Availability means the cloud-computing providers are able to provision and provide the required computing resources on demand. Security means cloud users' data integrity and confidentiality are critical functionalities provided by cloud-computing providers and must be done right (de Bruin & Floridi, 2017). Vendor lock-in, because of the lack of standardizations of cloud-computing services, makes it challenging to migrate among cloud-computing providers; thus, cloud users are trapped with their current cloud-computing providers. Inter-cloud integration, also because of the lack of standardizations among cloud-service providers, means data interfaces between two or more cloud-service providers or legacy in-house based systems can be challenging and cost much more than intra-cloud integration with the same cloud-computing provider. Based on these obstacles facing cloud computing, it is crucial for both cloud-service providers and cloud-service consumers to live up to their signed service level agreement (SLA) to build trust perspective and trustworthiness that is assessed and evaluated based on true collected data from multiple sources to establish trust relations between the providers and consumers (Noor, Sheng, Zeadally, & Yu, 2013).

RECOMMENDATIONS FOR ENSURING THE SUCCESS OF CLOUD-COMPUTING IMPLEMENTATION AND ADOPTION

Companies will continue to migrate their IT operations to cloud computing because of the benefits of migrating to cloud computing. Adoption can bring dramatic gains to the cloud users;

however, it can be a painful migration because using a modern cloud-computing environment is a big digital transformation. Recommendations for ensuring the success of cloud users' adoption and migration into a cloud-computing environment include:

1. It is recommended for cloud-computing consumers to be well-educated and knowledgeable of the proper cloud-computing services.
2. It is vital for cloud-computing consumers to rethink their operations in cloud computing, which will require adapting and training to access and interact with these cloud application services.
3. Cloud consumers must have a migration strategy plan based on well-documented business requirements.
4. Adopting cloud computing in an incremental approach starts by migrating small and simple applications to test drive the cloud-computing services before migrating the mission critical applications to cloud-computing services.
5. The service level agreement (SLA) must clarify the services' performance, compliance, and security considerations.
6. Cloud-computing services offer great opportunities and challenges, and cloud consumers must research and shop around to find the best service and best pricing among the huge and competitive pool of cloud-computing providers.
7. It is recommended to audit and evaluate cloud-computing services related to reliability and data integrity, availability, and security to assess and enhance the SLA.

CONCLUSIONS

In conclusion, cloud computing is disruptive technology to well-established on-premise infrastructures and software capabilities. Cloud computing is a major digital transformation that a cloud user must rethink how to operate and adapt to the proper cloud-computing service. Cloud computing is a paradigm for offering computing services as a utility through the internet. Cloud-computing companies such as Oracle, Google, Microsoft, and Amazon are leading and building massive cloud-computing technologies, i.e. data centers, that are highly redundant by their design to enable them to provide reliable and high availability services to their cloud users. Innovation in cloud computing continues at a rapid pace. All sectors (private, commercial, healthcare, public sector, government, and education) are now running some of their critical applications in the cloud, and many more are migrating their critical applications to the cloud, because cloud computing provides cost-effective, scalable, and flexible computing services. The computing resources are available for lease to the cloud users rather than purchasing the computing resources. Cloud computing allows the cloud consumers to pay only for what they use based on the cloud services they need. The incentives for cloud users are growing stronger as new standards and protocols are adopted and become widely used by cloud-service providers. The challenge of migrating among cloud-service providers will diminish, and costs of inter-cloud integration can be reasonably reduced by adopting common standards, which can incentivize businesses to migrate their in-house computing resources into cloud services and focus on their core competencies of a business. Cloud computing is bringing dramatic gains for cloud consumers. Indeed, cloud computing has been an IT industry game changer in recent years because it provides cost-effectiveness, flexibility, scalability, and interoperability (inter and intra-cloud integrations), and it is maturing rapidly as a leading innovation technology.

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