IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 21, Issue 3, Ser. VI (May - June 2019), PP 34-39
www.iosrjournals.org

Cloud Computing As A Service Era: Origins, Current And Future Trends

Iliyasu Adamu[1] Kabiru Ibrahim Musa[2] ShehuAbdulwahab[3]
Sulaiman Umar[4]
Department of Information Management Technology, Abubakar Tafawa Balewa University (ATBU) Bauchi, Nigeria.

Abstract: *Cloud computing as a service (aaS) model is considered as one of the most ubiquitous and accomplished paradigms in Information Technology (IT) in the 21st century, it is economic, financial and technological invention in business organization that revolutionized how IT resources and services are utilized and delivered as a service framework. The introduction of cloud computing as a service (aaS) framework in cloud computing eliminate the need for organization to locally manage and maintain Information System (IS) infrastructure as well as including the cost of buying expensive hardware and software. According to the available literature reviewed in this paper, the paper has studied the evolution of as-a-service (aaS) model framework and explore the new members to as a service (aaS) model beyond the traditional cloud service that will help in proposing an approach for organization that is trying to implement, migrate and adopt cloud computing as a service.*

Keywords: *Cloud computing, as-a-service (aaS) model*

Date of Submission: 22-06-2019 Date of acceptance: 05-07-2019

I. Introduction

Business nowadays are very good at what they do mostly and in today's competitive world. There is need to implement and adopt information system and a reliable computing system to achieve the core business objectives. Traditionally, business enterprises developed and managed their own in-house computing resource with or without an external partner. But for small to midsize businesses, it is a distraction and not possible to have a concentration on a functional computing system (Srinivasan, 2014). Al-jabri, Eid and Sohail (2018) assert that for a business enterprise to operate a private data center and manage software licensed to meet it computing processing demands is costly and complex. The costs of both time and money is relatively high to manage functional business information system. When cloud computing was introduced to business organization as a service (aaS), it became a viable option for most business enterprises that want to use the services at an affordable rate (Namasudra, 2018).

Cloud computing as a service (aaS) model evolved from the traditional outsourcing service model. In this service model, the necessary service is provided by a specialized organization in IT field as a contract. The contracting company and the user chooses a specific period of time for which the service is provided. Most business organization, instead of hosting and managing their in-house computing resources, contracted with some specialized organization to manage their Information System as a service. As such, their Information System is under the control of a third party. Often the contracting company handled all the information system of the organization. Although the business enterprises did not have problem with this arrangement because of the contracting agreement spelled out in Service Level Agreement (SLA) (Agrawal, 2019). Duan, et al. (2015) assert that Information System (IS) service is provided as a service by individual people or organizations, as Service-Oriented Architecture (SOA) and as Software as a Service (SaaS) in 2000 under Application Service Provider (ASP) and later as a cloud computing services (i.e. SaaS, PaaS & IaaS) after the introduction of cloud computing (Srinivasan, 2014).

Cloud computing as a service model is a global technology model that is offering businesses of all types an alternative way to acquire IT infrastructure at a minimal and affordable cost. By outsourcing IT services to cloud service provider on demand basis that is cheap and affordable. as a service (aaS) model is seen by Kulkami, Sutar and Gambhir (2012) as a good and alternative way for small or mid-sized business enterprise with a minimal resource to host and manage in-house Information Technology (IT) infrastructure and/or technical personnel required to implement and manage their IT infrastructure. As such Cloud computing as a service (aaS) model is considered as one of the most ubiquitous and accomplished paradigms in Information Technology (IT) in the 21st century, it is economic, financial and technological invention in business

organization that revolutionized how IT resources and services are utilized and delivered as a service framework. The introduction of as a service (aaS) framework in cloud computing eliminate the need for organization locally managing and maintaining Information System (IS) infrastructure that include not only the maintenance and management of IT infrastructure but the cost of buying expensive hardware and software (Agrawal, 2019).

II. Evolution of as a service era

The evolution and classification of as a service (aaS) era is a challenging and difficult task. According to research by Duan, et al. (2015) on evolution of as a service era from 1984 to 2014 shows that aaS is a continuous evolving terminology. For example, aaS is provided as a service by individual people or organizations, SOA (Service-Oriented Architecture), Software as a Service (SaaS) in 2000 under ASP (Application Service Provider) and later as a cloud computing services such as SaaS, PaaS and IaaS, Internet of Things (IoT) and Web of Things (WoT). For the purpose of these research paper cloud computing as a service model era are categorize under the traditional and the emerging era.

A. The traditional cloud computing as a service model

According to Kavis (2010) choosing the right cloud computing service model is a critical success factor for delivering cloud-based solutions in your company. In choosing the right services model solutions, the consumer must have a fully understanding of what each service model offers and the responsibilities the cloud service providers assume versus what the cloud service consumer assumes. The National Institute of Standards and Technology (NIST) United State agency for developing standards and guidelines defined three main types of traditional cloud computing as a service model. These service models are Software as a service (Saas), Platform as a service (Paas) and/or Infrastructure as a service (Iaas) (Mell & Grance, 2011).

Figure 1: Traditional cloud as a service model

Source: Namasudra (2018)

i. **Software as a Service (Saas)**: - Saas is also considered as a "Software on demand service", in this type of service model, a customer is provided with an internet connection access to software application through various client devices such as a web browser. The client accesses various software application service to run on the firewall or client personal computer (PC). The Saas services are offered to customers mainly through virtualization of cloud based uniform resources. According to (Mohan, Pandey, Bisht, & Pant, 2017) is a service running or take place on a software platform developed and provided by the PaaS layer. Google Mail, CRM, XDrive and Cloud based ERP are the major examples of SaaS.

ii. **Platform as a Service (PaaS)**: - as the name implies, it provides a platform or an environment as a service for developers to codes and develop software application platform suitable for appropriate Saas subscribers. Google App Engine and Microsoft Azure provides programmers with a cloud based environment to design, code and developed their various software applications. Paas is an abstraction layer of the cloud computing stack layer, that lies between Iaas and SaaS layer stack (Mohan *et al.* 2017). Mohapatra, Mohanty, pattanayak and Hota (2017) assert that Paas provides a various application services such as Team collaboration, database integration, security, web service integration and developer community facilitation. These can be referred to as an integrated solution as a service over the web.

iii. **Infrastructure as a Service (IaaS)**: - as the name implies, SaaS providers provides its customer with a virtual infrastructure such as servers, storage and other peripherals devices to be acquired as a service. The cost of setting up, acquiring and managing IT infrastructure are relative high and not affordable for some business enterprises, IaaS is the best options for those organizations to buy or used the infrastructural resources as a service and get billed based on the resources used. Mohan et al (2017) consider IaaS as the backbone of all cloud computing as a service model. Because is the bottom stack in cloud computing layer stack and it's the

layer that provide and host the IT infrastructure for the developer to developed application (PaaS) and used by the customer (SaaS). Amazon EC2, Flexiscale, Simple Storage Service (S3) and HP cloud are the major providers of IaaS as service now days. Some IaaS providers like Amazon Ec2 provides users with the physical and virtual resources such as Servers, OS, CPU, Memory and Storage access to meet their various customer requirements. While others provide its customers with the access to the virtual servers and Central Processing Unit (CPU) running several choice of Operating System (OS) (Mohapatra 2017).

Table 1: Comparative analysis of various traditional cloud computing as a service model

Parameters	**SaaS**	**PaaS**	**IaaS**
Service Providers	Google mail service	Microsoft Azure	Amazon web & IBM
Service Content	Cloud Application	Cloud Platforms	Cloud Infrastructure
Service Provided	Application software environment or Web portal	Development or deployment environment	Virtual Infrastructure environment
Stack layer Position	Top layer	Middle layer	Bottom layer
Users	Business environment	Developers &deployers	System manager
Accessibility	Web Portals	Scalable environment	Virtual resources
Visibility	End users	Partial Transparency	Full Transparency
Customization	Little customization	Platform customization	Infrastructure level customization
Management & Control	By the Customer	By the Vendor	By the Vendor
Cost	Minimum	Moderate	High
Privacy	Poor	Moderate	Accurate
Security	Accurate	Moderate	Poor

Source: Mohan et al (2017)

B. The Emerging cloud computing as a service model

This section provides different models under the cloud computing that are been categorized as services. These services are:

i. Biometrics Authentication as a service (BioAaaS): - is a form of biometric technology service powered authentication approach to perceived privacy and data protection in a web environment. BioAaaS service model is based on Software as a service (SaaS) models, where a client will be provided with only web browser access to service offered (Sharma, 2015).

ii. Business Integration as a service (BiaaS/BiaS): - BiaS is sometimes considered as Business Process as a Service (BPaaS). Is a form of services that enables the connections between business related services operating in cloud environment and integrates various business activities to achieve a streamline business process. By integrating different business process together into the same cloud platform can improve business activities, collaboration and reduced costs effectively (Chang, Walters, & Wills, 2012).

iii. Business Intelligence as a service (Biaas/Saas BI): - these is a form of cloud computing services that offers data access and control through a web interface for business intelligent process. According to Vo et al (2017) BiaaS is an automated intelligence business offer on cloud as a service to collect raw data from a heterogeneous data sources and organize such data in a systematical manner.

iv. Cashier as a service (CaaS): - is a form of cashier services rendered over a merchant website. Is a cloud computing services for third party payment system, that accept payment and other financial transaction for its registered customers. These services are usually offered by PayPal, Amazon payments system and Google checkout etc. Wang et al (2011) assert that CaaS plays a crucial role in today's e-commerce by providing maximum security required for both the shopper and the merchant.

v. Cloud-based Analytics as a service (ClAaaS): - is a form of cloud computing service model for big data analytics users, that provides on-demand data storage and analytics services for different user groups rendered over the web (Sharma, 2015).

vi. Confidentiality as a service (CaaS): - theses is a form of cloud computing service paradigm that provides bulk users a form of data protection, confidentiality and integrity as a service. The data security and protection is based on symmetric encryption techniques and visibility key-management mechanism (Sharma, 2015).

vii. Continuous Analytics as a service (CaaaS): - is a form of cloud computing service model that enables on-demand network access to users. These types of services are usually used for watching traffic status and detecting motor accident. According to Chen, Hsu and Zeller (2011) CaaaS is a cloud service model that enable the convenient on-demand access to a network of shared pool of event analysis.

viii. Cooperation as a service (CaaS): - is a form of cloud computing service-oriented solution for road users that improved an optimized use of the road networks. These services are usually rendered through vehicles cooperation and vehicles-to-vehicle communication system for optimized used of the roads (Sharma, 2015).

ix. Data Analytics as a Service (DAaaS) is an extensible analytical platform provided using a cloud-based delivery model, where various tools for data analytics are available and can be configured by the user to efficiently process and analyze huge quantities of heterogeneous data (Sharma, 2015).

x. Data as a Service (Daas): - is a form of APIs cloud-assisted computing services that deliver on-demand APIs services to consumer. These service provide consumer with an APIs service environment to fetch and store giant data assets and easy data asset fetching and recovery (Sharma, 2015).

xi. Database as a service (DbaaS): this involves cloud computing client outsourcing database storage, control, security and service to the database service providers in an encrypted format (Hacigumus, Iyer, & Mehrotra, 2002). In these type of cloud services, client move much of the operational burden of database configuration, security, privacy, access control, performance and data recovery to the database cloud providers offering lower overall service cost (Sharma, 2015). Amazon RDS and Microsoft SQL Azure are the early and most popular cloud service providers that offer database storage, security and control as a service over the years.

xii. Data Mining as a Service (DMaaS): - this involves a cloud computing client outsourcing for its organization data mining as a service to the selected service provider. DMaaS allows the client to leverage hardware and software solutions provided as a service without developing in-house data center. DMaaS service is a best and alternative solution for some business organizations with a large volume of data and limited budget for data analysis to outsource for their data and data mining needs to service provider (Sharma, 2015).

xiii. DDoS as a Service (DDoSaaS): - with numerous DDoS attacks launch on the internet now a day, DDoSaaS is offering such attack online as a service to its customer. According to Santanna et al, (2015) these type of service is usually offered by Booters sites, they provide DDos attack as a paid service online at a cost ranging from 1 USD to several dollars. Booters service were used to launch numerous attacks against personal websites, government agencies and other booters sites.

xiv. Desktop as a service (DaaS): - is a form of cloud computing service similar to Saas, where a client or customers is provided with an application software access to the on-demand services over the internet. DaaS provides software access service over the internet on the bases of pay-as-you-go service model. DaaS is a delivery of a virtual client desktop application as a service over the internet that change the way users purchased and manage their desktop applications (Miller, 2017).

xv. Digital Forensic as a Service (DFaaS): - is a service-based approach for investigating and processing high volume of seized digital materials. According Van Baar et al. (2014) DFaaS was developed since December 2010 at the Netherlands Forensics Institute (NFI) and funded by the Dutch Government as a new service-based approach for processing high volume of digital materials such as Personal Computers (PCs), Smartphones, Tablet and other digital devices. FDaaS service is based on Xiraf, Non-Commercial product and closed-source service model.

xvi. Education and learning as a service (ELaaS): - is a form of cloud computing services rendered in education and learning environment. ElaaS provide an avenue for effective learning environment that enables students/learners, instructors and its administrator's interaction (Sharma, 2015).

xvii. Everything as a Service (XaaS): - it is also known as Anything as a service, it is a form of cloud computing service that delivers anything as a service to its customers over the internet rather than provide locally or on-site within an organization network (Duan, et al., 2015).

xviii. Failure as a service (FaaS): - also known as a Resiliency as a Service (RaaS) or controlled disruption. It is an online cloud based automatic failure drills services, offered as a service to protect business transactions process failure for large-scale business organization. FaaS implements and adopts the failure testing approach in real deployment. The major goal of FaaS is to perform failure drills from time to time to find the real deployment scenario before experiencing unexpected failure. (Gunawi, et al., 2011).

xix. Gaming as a service (GaaS): - it is an upcoming trend in game industry where a cloud computing service game environment is provided as a service to users over internet. This cloud gaming environment provide users with a scalable, ubiquitous, cross-platform and cost effective game environment on-demand basis over the traditional software systems. (Cai, Huang, Chen, & Leung, 2016).

xx. Manufacturing as a Service (MFGaaS): - also considered as a cloud-based manufacturing service model. MFGaaS is an advanced enterprise manufacturing model developed and delivered as a service over a cloud computing paradigm under the support of enterprise information technology such as IOT, virtualization, advanced computing and service oriented technologies (Sharma, 2015). It provides safely and reliable on-demand various manufacturing services online. Siderska and Jadaan (2018) assert that MFGaaS is an emerging technology that joins the cloud computing family such as IOT and service-oriented technologies – for solving complex manufacturing application problem and support large scale manufacturing collaborative.

xxi. Recovery As a service (RaaS): also known as a Disaster Recovery as a Service (DRaaS), with the introduction of RaaS as s service platform in cloud computing: enable business enterprises recover their data backup, archiving and data disaster recovery in a single integrated platform as a service. Raas provides users with a maximum data security and easy data recovery of their entire data centers, servers and database and reduced the risk of data recovery process (Sharma, 2015).

xxii. Security as a service (Secuaas/SaaS): - is a form of data protection and security as service over the internet. Saas is cloud computing service model that enables data protection and security of an organization data center over the web (Sharma, 2015).

xxiii. Storage as a Service (SaaS/STaaS): - is a cloud computing business service model where large and complex organization rents space in their online storage infrastructure to a less privilege company or individual to store and process their data. Users data security and privacy are the major concern in SaaS model, as such robust cryptographic algorithm are used to safe guard the user's data. With STaaS small and Mid-Size business enterprises are able to store their data successfully without the burden of maintaining in-house IT infrastructure (Sharma, 2015).

xxiv. Supply Chain as a Service (SCaaS): -is a form cloud computing supply chain service model that enables an organization product procurement, production control, manufacturing, warehousing and logistics as service over the web (Sharma, 2015). SCaaS services reduced production cost by partnering with one or more service provider to support all or part of the organization supply chain as a service over the web (Kulkarni, Sutar, & Gambhir, 2012).

xxv. Testing as a Service (TeaaS/TaaS): - is a new business and service model, where TaaS client is provided with web-based (or application system) software testing environment related to project activities as a service over cloud computing (Gao, Bai and Tsai, 2013; Sharma, 2015).

III. Methodology

The paper is a review paper that uses secondary data. The data were collected using secondary sources which are mostly journals and research articles.

IV. Conclusion

With the introduction of cloud computing in business organization as a service (aaS), it became a viable option for most business enterprises that want to use the services at an affordable rate. These is a global technology model that is offering businesses of all types an alternative way to acquire IT infrastructure at a minimal and affordable cost through outsourcing IT services to cloud service provider on demand basis that is cheap and affordable. That will save the costs of both time and money that is relatively high to manage functional business information system. Cloud Computing as a service (aaS) is provided as a service by individual people or organizations, Service-Oriented Architecture (SOA), Software as a Service (SaaS) in 2000 under Application Service Provider (ASP) and later as a cloud computing services such as SaaS, PaaS and IaaS, Internet of Things (IoT) and Web of Things (WoT). But later some new members have joined the family, 25 of such members were discussed in this work and a lot more are coming in due time.

References

[1]. Agrawal, G. (2019). A survey on the "vision of cloud computing - its referential architecture, characteristics and applications". Journal of current science, 20(1).

[2]. AL_Jabri, I. M., Eid, M. I., & Sohail, M. S. (2018). A group decision-making method for selecting cloud computing service model. International journal of advanced computer science and apllication (IJACSA), 9(1), 449-456.

[3]. Cai, W., Huang, C., Chen, K., & Leung, V. C. (2016). Gaming, The Future of Cloud. Proceedings of the IEEE, 104(4), 687-691. doi:https://www.researchgate.net/publication/298799626

[4]. Chang, V., Walters, R. J., & Wills, G. B. (2012). Business integration as a Service. International Journal of Cloud Application and Computing, 2(1), 1-20.

[5]. Chen, Q., Hsu, M., & Zeller, H. (2011). Experience in continuous analtics as a Service (CaaaS).

[6]. Duan, Y., Fu, G., Zhou, N., Sun, X., Narendra, N. C., & Hu, B. (2015). Everything as a Service (XaaS) on the Cloud: Origins, Current and Future Trends. 2015 IEEE 8th International Conference on Cloud Computing, 621-628.

[7]. Gao, J., Bai, X., & Tsai, W. (2013). Testing as a Service (TaaS) on Clouds. 2013 IEEE Seventh International symposium on service-oriented system Engineering, 212-223.

[8]. Gunawi, H. S., Do, T., Hellerstein, J. M., Stoica, I., Borthakur, D., & Robbins, J. (2011). Failure as a service (FaaS): A cloud service for large-scale, online failure drills. 1-8. Retrieved February 13, 2019, from http://www.eecs.berkeley.edu/Pubs/TechRpts/2011/EECS-2011-87.html

[9]. Hacigumus, H., Iyer, B., & Mehrotra, S. (2002). Providing database as a service. International Conference on Data Engineering .

[10]. Kavis, M. J. (2014). Architecting the cloud design decision for cloud computing service model (Saas, Paas and Iaas. John Wiley and Sons Inc.

[11]. Kulkarni, G., Sutar, R., & Gambhir, J. (2012). Cloud Computing - storage as service. International Journal of Engineering, 2(1), 945-950.

[12]. Mell, P., & Grance, T. (2011). The NIST defination of Cloud Computing; Recommendations of the National Institute of Standards and Technology. US: National Institute of Standard and Technology. Retrieved February 03, 2019, from https://csrc.nist.gov/projects/cloud-computing

[13]. Miller, L. (2017). Desktoip as a Service (DaaS) for dummies. John Willey & Sons.

[14]. Mohan, L., Pandey, R., Bisht, S., & Pant, J. (2017). A comparative study on SaaS, Paas and Iaas cloud delivery models in Cloud Computing. International Journal on emerging technologies (Special issue NCETST-2017), 8(1), 158-160.

[15]. Mohapatra, S., Mohanty, S., Pattanayak, S., & Hota, A. (2017). Comparison of various platforms in cloud Computing. International Journal of Computer Applications, 162(7), 28-33.

[16]. Namasudra, S. (2018). Cloud computing: a new era. Journal of fundamental and applied sciences, 113-135.

[17]. Naous, D., schwarz, J., & Legner, C. (2017). Analytic as a Service: Cloud Computing and the transformation of Business analytics Business models and ecosystems. Twenty-Fifth European Conference on Information Systems (ECIS). doi:https://www.researchgate.net/publication/317825459
[18]. Santanna, J. J., Rijswijk-Deij, R. V., Hofstede, R., & Sperotto, A. (2015). Booters - An analysis of DDoS as a Service attacks. 2015 IFIP/IEEE International Symposium on Integrated Network Management (IM2015), 243-251.
[19]. Sharma, S. (2015). Evolution of As-a-service Era in cloud. 1-14.
[20]. Siderska, J., & Jadaan, K. S. (2018). Cloud Manufacturing: A service-oriented manufacturing paradigm. A review paper. Engineering Managemnt in production and services, 10(1), 22-31.
[21]. Srinivasan, S. (2014). Cloud Computing basics. New York: Springer. Retrieved January 23, 2019, from http://Springer.com/978-1-4614-7698-6
[22]. Van Baar, R. B., A, V. B., & Van Eijk, E. J. (2014). Digital forensics as a service: A game changer. Digital Investigation, 11, 554-562. Retrieved March 01, 2019, from http://www.elsevier.com/locate/diin
[23]. Vo, Q. D., Thomas, J., Cho, S., De, P., Choi, B. J., & Sael, L. (n.d.). Next generation Business inteligence and analytics: A survey. IEEE Communication surveys and tutorials, 1-11.
[24]. Wang, R., Chen, S., Wang, X., & Qadeer, S. (2011). How to shop for free online: Security analysis of Cashier-as-a-Service based web Stores. 2011 IEEE symposium on security and privacy, 465-480.

Iliyasu Adamu. “Cloud Computing As A Service Era: Origins, Current And Future Trends. " IOSR Journal of Computer Engineering (IOSR-JCE) 21.3 (2019): 34-39.