Adoption of Cloud Computing Technology for Effective University Administration in Nigeria

Imran A. Adeleke[1], Ismail O. Muraina[1*] and Kazeem K. Adegbuyi[1]

[1]*Department of Computer Science, School of Science, Adeniran Ogunsanya College of Education, Otto/Ijanikin, Lagos, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. Author IAA designed the study, wrote the first draft of the manuscript and sourced for materials in writing related literatures. Author IOM wrote the methodology, performed statistical analysis and discussed the findings. Author KKA collected data for the study and wrote the conclusive part of the study. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Cloud computing is a technology that represents a shift from the traditional ownership of infrastructure and other resources to a more scalable pattern in which computer resources are rented online to organizations on either as a pay-as-you-use basis or by subscription. The researcher is motivated to undertake this study due to cloud computing growing awareness which has led to the increasing adoption of the technology by organizations in Nigeria including educational sector. However, the challenges that comes with the technology slow down the rate of its adoption by many universities in Nigeria and making them unconvinced to entrust into the cloud technology. This work investigates the use of cloud computing technology for effective administration in Nigerian universities. From analysis, the research reveals the strengths, weaknesses, opportunities and threats in the adoption of cloud technology and points out the concerns and challenges impeding its adoption. It further discusses the enormous benefits the universities stand to gain for adopting the cloud technology and proffers threat mitigation techniques to prevent the occurrence of the impediment towards the cloud adoption. The finding also recommends some cloud platforms as a means of IT delivery services for effective university administration.

Corresponding author: E-mail: niyi4edu@gmail.com;

1. INTRODUCTION

Cloud computing is a new technology that is still evolving across the information technology industry and educational institutions. Cloud computing, which evolved from the Internet and the web, sets the pace for a new age of global computing as it changes the way we work, think, do business, and communicate. It is a practical innovation that entails the renting of common business applications or services online by cloud computing service providers to clients on either as a pay-as-you-go basis or by subscription.

Cloud computing has some characteristics that distinguish it from other technologies [1,2]. They include the following: Users do not necessarily have to own the information technology (IT) resources they utilize. For instance, the servers they network with might be hosted in data centers at remote locations from them, Also, services are provided on-demand to the end-users and the end-users only pay for what is used and Cloud services can be delivered as software (SaaS), platform, (PaaS), or infrastructure (IaaS) [1]. SaaS is a model in which application software is delivered via the Internet [3]. PaaS is a model where, the service providers supply services to the users, such as development environment, and server platforms through which the users can develop custom applications. In IaaS, computer infrastructure such as servers and storage devices are remotely delivered through the Internet.

Cloud computing has moved from just being a topic of interest and debate to one that is being adopted and applied to various aspects of the economy in sub-Saharan Africa - prominently the enterprise [4] and in recent times the education sectors. A recent study has identified the need for Nigerian educational institutions to have a plan of action for the adoption of cloud services [5].

Cloud computing, which is a challenging new technology, is strange to the African continent and Nigeria in particular. This is borne out of the fact that Nigeria falls short of the basic IT infrastructure requirements (such as steady electricity, and poor internet connectivity) for the effective adoption of the technology.

The study tends to find answers to the following research questions which were posed to guide the study.

i. Which of the cloud computing technology can be adopted for effective university administration?
ii. Which of the impediments most affect the adoption of cloud technology in Nigerian Universities?
iii. Which of the benefit contribute to easy adoption of cloud technologies in Nigeria universities?

2. RELATED LITERATURE

Cloud computing is certainly a technology that has come to stay as several organizations, governments, and individuals are encouraged to kin into this emerging smart technology. However, it is worthy of note that this technology is built upon already existing technologies. Cloud computing is a new trend of delivering information and technology services. It refers to both the hardware and software that delivered applications as services over the web [6]. A virtual environment of computing services could be constructing using cloud computing, particularly in the domains of online education [7,8]. Moreover, IT experts believe that institutions based on cloud services will continue to raise and evolve in the next few years [9]. Cloud service providers can deliver computing resources as a package of software, hardware that include as a platform. Moreover, it considers as alteration from application as a product that is possessed, to application as a service that is carried from enormous data centers to clients over the internet [9].

In addition, the cloud services, and computing resources can be accessed via shared servers and networks [10]. Cloud services allow clients to use software and hardware that are run by third parties at remote servers. Cloud services can be classified into Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

According to Taylor [11] observed that cloud-based software is the default deployment method in 2020 for nearly every type of business technology in the world. SaaS is a method of software delivery that allows data to be accessed from any device with an internet connection and web browser. According to Stephen Watts and Muhammad Razar [12] observed that the cloud is a broad concept that covers a lot of online

territory. They revealed that SaaS (Software as a Service) is known as cloud application services, which represents the most commonly utilized option for businesses in the cloud market. SaaS utilizes the internet to deliver applications, which are managed by a third-party vendor, to it users. Due to its web delivery model, SaaS eliminates the need to have IT staff download and install applications on each individual computer. SaaS provide numerous advantages to employees and companies by greatly reducing the time and money. PaaS (Platform as a Service) provide cloud components to certain software while being used mainly for applications. PaaS deliver a framework for developers that they can build upon and use to create customized applications. The delivery model of PaaS is similar to SaaS except instead of delivering the software over the internet, PaaS provides a platform for software creation. This platform is delivered via the web, giving developers the freedom to concentrate on building the software without having to worry about operating systems, software updates, storage or infrastructure while IaaS (Infrastructure as a Service) are made of highly scalable and automated computer resources.

IaaS is fully self-service for accessing and monitoring computers, networking, storage and other services.

In looking at the comparison between SaaS, PaaS and IaaS, the Table 1 compares SaaS, PaaS and IaaS using different course areas using cloud computing, mobile technology, internet of things, big data, IT managements, computer simulation and virtual reality [13].

According to Uzoka, Akinnuwesi, Olabiyisi and Demilade [14] conducted a study on the potential for the adoption of grid computing in tertiary institutions of Nigeria. The study revealed a significant lack of awareness about the benefits of grid computing particularly in tertiary institutions.

Ofemile, [15] similarly conducted a study to assess affordances of selected cloud computing tools for language teacher education in Nigeria. The study revealed that participants were able to perceive the opportunities inherent in the use of cloud computing for classroom learning as well as the unintended affordances.

Table 1. Comparison of SaaS, PaaS and IaaS

Course area	SaaS	PaaS	IaaS
Cloud Computing	-Communication apps -Cloud storage apps -Social computing apps - Apps management -web hosting service	-cloud based simulation -Development of cloud software (google engine windows azure, amazon)	-Virtualization -Software defined networks -Software defined data centres -Cloud storage
Mobile Technology	-Mobile commerce apps -M-payment apps -Mobile learning apps -Mobile social apps	-SMS API -Mobile application development -Mobile agents -Mobile cloud applications	-Software defined radio networks
Internet of Things	-Software for smart device management	-API for accessing the sensor data -API for context-aware applications -API for wearable computing applications	-Software defined wireless sensor network -Smart environments
Big Data	-Data analysis -Visualization	-Map-reduce API	-Environments for hadoop projects -Environments for mongoDB projects
IT managements	-Project management software -CRM software	-Salesforce PaaS -Heroku PaaS	-Cloud management
Computer Simulation and Virtual Reality	-Web simulation software -3D modeling software tools	-API for developing 3D models	-Resources for simulation execution -Environment for rendering

According to Dahunsi, and Owoseni, [16] a critical analysis of the benefits and challenges of the adoption and usage of cloud computing in Nigeria was performed. In the study, the relationship between key stakeholders in the Nigerian cloud ecosystem and proposed methods for optimizing the benefits of cloud computing while reducing the inherent adoption challenges was presented. This study however, focused on businesses and corporate organizations as being the consumers of cloud technology and not educational institutions. The study also deemphasizes the cloud service delivery channels (IaaS, PaaS, and SaaS) arguing that the rise of cloud ecosystem would render them irrelevant. Therefore, the challenges identified in this study were for the cloud ecosystem and not for the service delivery models.

In the work of Islam, Kabir, Hossain, Chakraborty and Majadi, [17] a framework was proposed that would help organization of public and private sectors in Bangladesh to adopt cloud computing technology opportunities and prevent its obstacles. Although SWOT Analysis was performed in this study, it was not directed at the service delivery channels of cloud computing.

According to Awosan, [18], conducted a study on the cloud service adoption extent in Nigeria, he observed that the cloud service adoption was still low. Also of all the available cloud computing services, SaaS was the most used in Nigeria.

Although, grid computing is not exactly cloud computing, they share a lot in common especially in terms of vision, architecture and technology [19]. To Dogo, Salami, and Salman, [20] also observed that the opportunities and challenges are seriously affecting the adoption of cloud computing in Nigeria

In the same study of Oyeleye, Fagbola and Daramola [21] confirmed SaaS as the most used cloud service followed by PaaS and lastly IaaS in nigeria universities.

According to Popović and Hocenski, [22] argued that according to the International Data Corporation (IDC) survey, Security of data in cloud ranked top as the highest issue or risk in cloud computing environment. Most of the companies are facing a major issue about to move their vital information into public and shared cloud environment which is going to outside of their network defence and control. Cloud computing has several advantages, there are also some disadvantages related to this new technology. Various issues that have been examined by other researchers are concerns related to the cloud's complexity, security and privacy [23].

3. METHODOLOGY

This study adopted the descriptive sample survey research design. This design is considered suitable because it enables the researcher to generate data through standardized collection based on highly structured instrument and well defined related variables. The accessible population of this research consists of all the students and staff of Universities including outreach campuses. The researcher purposively selected one hundred (100) respondents among the staff, undergraduate and postgraduate students of Lagos State Universities (LASU). Therefore, the sample size for the study was 100 respondents with the use of simple random sampling techniques. Structured questionnaire was used as an instrument to collect data from the respondents. The instrument was face and content validated by expert in the field of information technology. The instrument reviewed 0.788 reliability index. The researcher administered the questionnaires to the respondents. The responses gathered from the questionnaires were analyzed using pictorial representation (bar-chart).

3.1 Analysis and Result

Which of the cloud computing technology can be adopted for effective university administration?

The Fig. 1 shows that SaaS is the most adopted cloud service for effective university administration, followed by PaaS and lastly IaaS. From Fig. 1, respondent of about 85% agreed that SaaS is mostly adopted for university administration while 10% of respondent agreed that PaaS is next use for university administration. Lastly 5% of the respondent agreed that IaaS is the list used for university administration.

Which of the impediments most affect the adoption of cloud technology in Nigerian Universities?

The Fig. 2 shows that security mostly affect the adoption of cloud technology in Nigerian Universities, followed by electricity and lastly file threat. This implies that majority of the

respondent (60%) collectively agreed that security is the most challenging factor to the adoption of cloud computing, next to this is electricity of which 30% of the respondent claimed to be a challenging factor and lastly the rest of the respondent observed that file threat is the list challenging factor to the adoption of cloud computing with 10%.

Which of the benefit contribute to easy adoption of cloud technologies in Nigeria universities?

The Fig. 3 reveal that easy accessibility is most benefit contribute to easy adoption of cloud technologies in Nigeria universities, next to it is low cost, followed by no risk of life and lastly easy storage. This means that 50% of the respondent agreed that easy accessibility of materials, tools, documents e.t.c on the cloud are easily accessed. 25% of the respondent claimed that the cheap rate of adopting cloud materials, tools, documents e.t.c is more beneficial. 15% of the respondent agreed and believed that no risk of life is more beneficial to people adopting cloud materials, tools, documents e.t.c while the remaining 10% of the respondents claimed that there is easy storage in adopting cloud materials, tools, documents e.t.c.
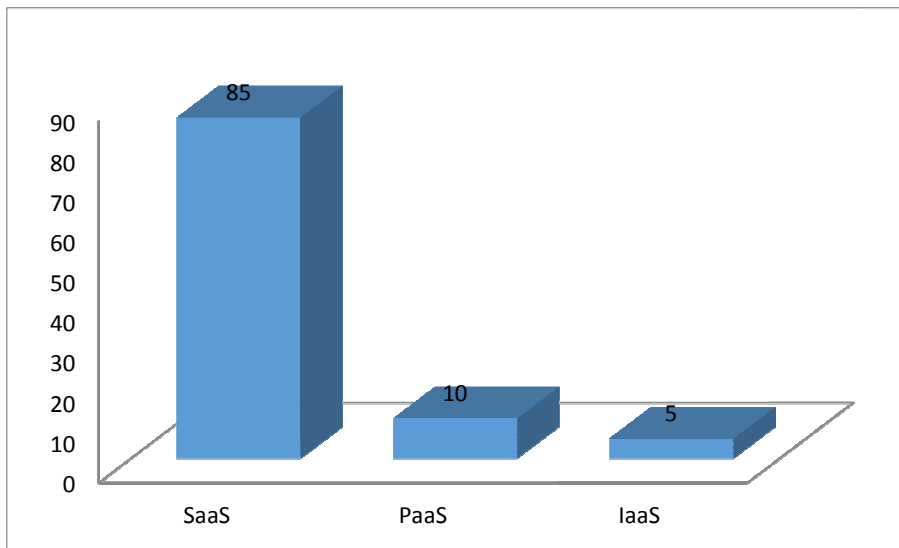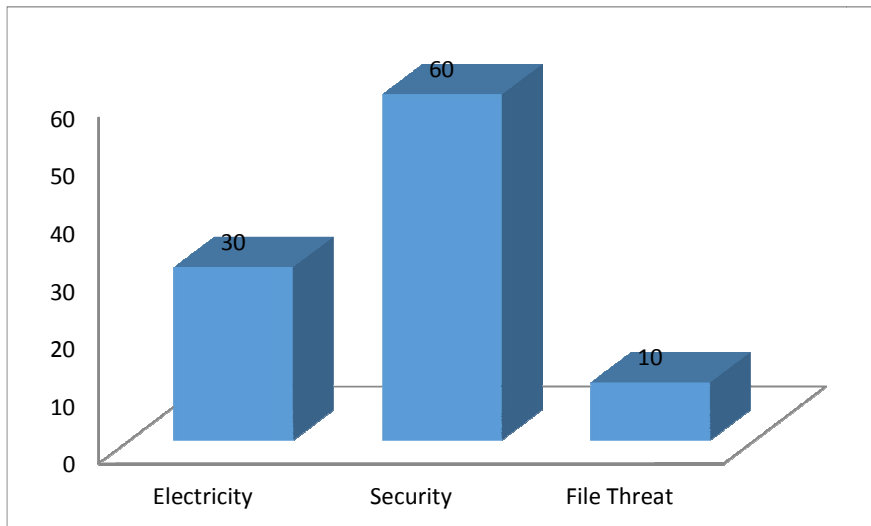

Fig. 1. Cloud computing technologies

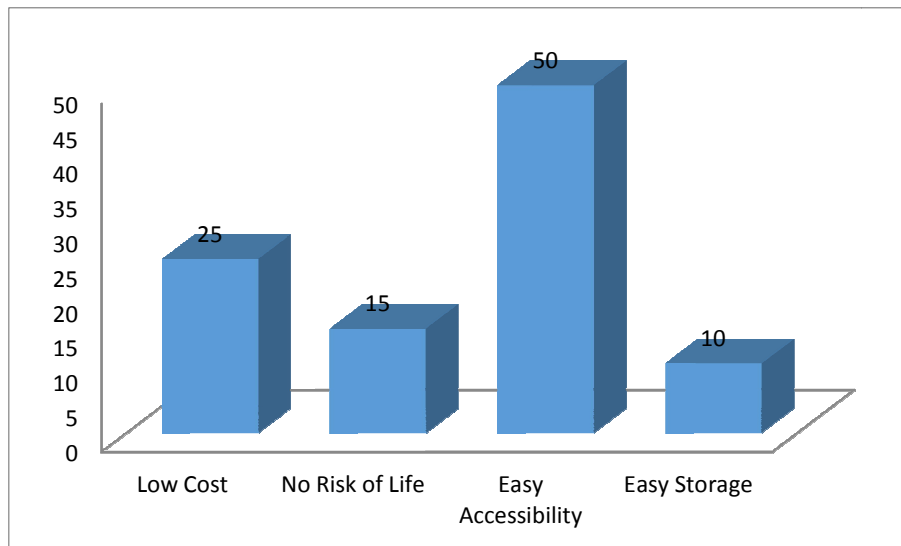**Fig. 2. Impediments to cloud technology adoption**

Fig. 3. Benefit of cloud technologies adoption

4. DISCUSSION OF FINDINGS

According to this study, out of cloud computing service technology observed Software as a Service (SaaS) was the only cloud computing service technology mostly used in Nigeria University Administration. Though, others like Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) were available but not as used as SaaS. This findings was in line with the study of Oyeleye, Fagbola and Daramola [21] who confirmed that SaaS as the most used cloud service followed by PaaS and lastly IaaS in nigeria universities.

In the study, the challenges facing the adoption of cloud computing security challenges, electricity and file threat were observed as major impediment that could affect the adoption of cloud computing service technology for university administration. Among these impediments security challenge stood out as most the impediment that affect the adoption of cloud computing service technologies. This ascertion was supported with the study of Wang et al. [24] which stated that the cloud computing adds new security threats to outsourced data in cloud environment. In cloud technology, data out sourcing is allowing cloud service providers assumed as separate administrative distinct controls, due to that cloud users are surrendering the control of their own data to fate. Therefore the correctness of the out sourced data remains at the risk. And also Wang et al. [24] mentioned that the infrastructure of cloud threaten by lot of challenges for data integrity from both internal and external sides.

Furthermore, there is enormous benefit derivable by the adoption of cloud computing by Nigerian universities. The research shows that easy accessibility to the information on cloud computing service by university staff and students making it stand out from among other benefits such as low cost (Reduced hardware and infrastructure costs, reduced software costs, reduced staff costs, reduced security costs, reduced training costs, enhanced availability, cost effectiveness / affordability), no risk of life and easy storage of information.

5. CONCLUSION

In looking at adoption of cloud computing technology for effective university administration in Nigeria. The study looks at what university administration will gain by adopting cloud computing for her administration activities. The study further made it clear that the adoption of cloud computing would be beneficial to both academic and non-academic staff of the university with little or no cost. From the literatures the study confirmed the availability, benefit and problem facing the adoption of cloud computing technology for effective administration in university. It was observed that SaaS remain the most used cloud service among others. Similarly, cloud computing adoption as really changed university administration in terms of easy accessibility, easy storage and easy

administration without forgetting it challenges such as security and threat.

6. RECOMMENDATION

The future of cloud computing in Nigeria is bright if government and all stakeholders would put all hands on deck to ensure that these identified challenges/impediments to its feasibility are addressed squarely. On this note, the researcher proffers the following recommendations which if implemented would enhance the effective adoption of cloud computing in Nigeria.

- ❖ The unreliability of power supply in the country needs to be taken seriously and resolved as soon as possible. This is because electricity is very essential especially in the running of data centres.
- ❖ There should be intensified awareness creation by cloud service providers geared at sensitizing the public on the benefits and risks of cloud adoption by organizations in Nigeria.
- ❖ More cloud service providers are needed in the country to encourage competition which will result to the driving down of the cost of its services. This would make the technology more appealing to organizations.
- ❖ Cloud providers in Nigeria should be able to provide free trials of their services to their targeted organizations at a stipulated period of time to encourage them to adopt the technology.
- ❖ More data centres should be established in the country to improve the access to cloud computing resources, reduce costs of access, increase monitoring for security purposes, and protect local content.
- ❖ There should be a strong legal framework on data protection which should be in line with international best practices. When this is properly put in place, clarification of relations between data centre managers and clients, as well as service level agreements would be enhanced.
- ❖ The implementation of the submission of a committee set up by the federal government to develop a national broadband strategy and roadmap for Nigeria would go a long way in helping the growth of cloud computing in Nigeria. The implementation is geared towards increasing internet and broadband penetration across the country tremendously. The intention is to ensure

that all state capitals and urban cities will have metro-fibre infrastructure installed within the implementation period. The key objectives of the plan as highlighted include the promotion of pervasive broadband deployment, increasing its adoption and usage, and ensuring availability of broadband services at affordable rates.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mell P, Grance T. The NIST definition of cloud computing [Online]; 2015. Available:http://csrc.nist.gov/publications/nistpubs/800145/SP800-145.pdf (Date Accessed: 19th March, 2017)
2. Jain S, et al. A comparative study for cloud computing platform on open source software. International Journal of Engineering & Technology (AIJET). 2014;1:28-35.
3. Mohammad AF, Mcheick H. Cloud services testing: An understanding. Procedia Computer Science of Social & Economic Development. 2011;5:513-520.
4. Uchenna CP, et al. Overcoming the barriers to enterprise cloud adoption within Nigerian consumer constituency. British Journal of Mathematics & Computer Science. 2015;8:39-56.
5. Aginam E. Microsoft takes Live@edu cloud service to LBIHS [Online], Vanguard; 2015. Available:http://www.vanguardngr.com/2012/03/microsoft-takesliveedu-cloud-service-to-lbihs/#sthash.AhhAJ3Ye.dpuf
6. Armbrust M, Fox A, Griffith R, Joseph AD, Katz R, Konwinski A, et al. A view of cloud computing. Communications of the ACM. 2010;53(4):50-58.
7. Al-Zoube M, El-Seoud SA, Wyne MF. Cloud computing based e-learning system. International Journal of Distance Education Technologies (IJDET). 2010;8(2):58-71.
8. Klug W, Bai X. Factors affecting cloud computing adoption among universities

and colleges in the United States and Canada. Issues in Information Systems. 2015b;16(3).

9. Abdollahzadegan A, Hussin. The organizational critical success factors for adopting cloud computing in SMEs. Journal of Information Systems Research and Innovation (JISRI). 2013;4(1):67-74.

10. Makoza F. Cloud computing adoption in higher education institutions of Malawi: An exploratory study. Computing and ICT Research. 2016;9(2):37-54.

11. Taylor Short. What is SaaS (Software as a Service)? 2020.
(Retrieved on the 15th November 2020)
Available:www.researchgate.net

12. Stephen Watts, Muhammad Razar. Comparison of SaaS (software as a Software), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service); 2019.
(Retrieved on the 15th November 2020)
Available:www.researchgate.net

13. Bozidar Radenkovic, Marijuana Despotovic-Zrakic, Zorica Bogdanovic, Vladimir Vujin. Harnessing cloud computing infrastructure for E-learning services. University of Belgrade, FACTA UNIVERSITATIS Series Electronic and Energetics; 2014.
(Retrieved on the 15th November 2020)
Available:www.researchgate.net

14. Uzoka FME, et al. An empirical study of potentials of adoption of grid computing as a vehicle for tertiary institutions collaboration. International Journal of Business Information Systems. 2012;10: 245-263.

15. Abdulmalik Yusuf Ofemile. Assessing affordances of selected cloud computing tools for language teacher education in Nigeria. University of Nottingham.
Available:www.researchgate.com

16. Dahunsi, Owoseni. Cloud computing in Nigeria: The cloud ecosystem perspective; 2015.
Available:www.researchgate.com

17. Islam S, et al. Cloud computing technology in Bangladesh: A framework of social and economic development. European Scientific Journal. 2015;11:393-410.

18. Awosan. Factor analysis of the adoption of cloud computing in Nigeria; 2014.
Available:https://ms.academicjournals.org/author_requests/update

19. Foster, Zhao, Raicu, Lu. Cloud computing and grid computing; 2008.
Available:https://www.researchgate.net/publication/23716795_Cloud_Computing_and_Grid_Computing_360-Degree_Compared

20. Dogo, Salami, Salman. Feasibility analysis of critical factors affecting cloud computing in Nigeria. October 2013 International Journal of Cloud Computing and Services Science (IJ-CLOSER). 2013;2(4).

21. Oyeleye, Fagbola, Daramola. The impact and challenges of cloud computing adoption on public universities in Southwestern Nigeria August 2014. International Journal of Advanced Computer Science and Applications. 2014;5(8):014.

22. Kresimir Popovic, Zeljko Hocenski. Cloud computing security issues and challenges; 2010.

23. Tehrani SR, Shirazi F. Factors influencing the adoption of cloud computing by small and medium size enterprises (SMEs). Paper Presented at the International Conference on Human Interface and the Management of Information; 2.

24. Wang B, Zheng Y, Lou WJ, Hou T. DoS attack protection in the era of cloud computing and software-defined networking. North Carolina, IEEE; 2014.