

A Survey On Cloud Computing, Security Challenges, Architecture, Applications & Solutions

Hadiqua Fazal¹, Imran Memon^{1*}, Tarwan Kumar Khatri¹, Ghulam Muhammad¹, Qasim Ali²

¹ Department of Computer Science, Bahria University, Karachi campus, Sindh, Pakistan

² Department of Software Engineering, Mehran University of Engineering & Technology, Jamshoro
hadiqua.bukc@bahria.edu.pk, imranmemon.bukc@bahria.edu.pk, tarwan.bukc@bahria.edu.pk
ghulammuhammad.bukc@bahria.edu.pk, qasim_ali_arain@yahoo.com

Abstract: In this paper, we are going to emphasize on the advancement in computing technology cloud computing is an incredible innovation to perform complex processing. It decreases the need of costly equipment's and dedicated storage. The connection between information and cloud computing is inspected along .The definition, attributes and grouping of huge information along with certain discourses on cloud computing are presented with focus on accessibility, information honesty, information quality, adaptability, security and administration. There is a rapid development in cloud computing and Internet of things regard the field of wireless communication. We present a survey on the security issues of both the technologies. We studied about the contributions of cloud computing to the Internet of things technology. It will illustrate the improvements on the internet of things on the basis of cloud. We will discuss the pros and cons of merging the technologies. The financial effects on innovation will be discussed, it will mainly emphasize on macroeconomics development. In this examination the results of rivalry and market structures will be brought to spotlight. Secondly the impact on industries and firms renting the storage from the providers will be discussed and how it effects the economics. Vehicular networking has become a significant area due to standardization, traffic management, road safety and infotainment. Vehicles carry more communication systems in sensing power. It can promote intelligent transportation system. Vehicular cloud computing remarkably effects traffic, the executives and street security in a split by utilizing the vehicular assets.

Keywords:.. security; cloud computing; applications;

I. INTRODUCTION

The name cloud is given on the perception of a cloud, that how it is not under any restrictions and can be accessed globally. Cloud computing is a platform that provides global on demand network access to a shared group of computing resources, like (networks, server, storage, applications and services). It can be provided in short time; it does not require large amount of management team. For example, through a literature review we can design an architecture of vehicular cloud computing. Vehicular cloud computing is feasible and economically viable technology for intelligent vehicular network towards autonomous traffic and vehicle control [1-4].

Cloud computing draws magnificent attention to the IT community. It gains more impact on the communication technology community. Some of its aspects are flexibility, cost efficiency, and more powerful mobile networks. It provides elasticity, virtualization, service metering, multitenancy, resource pooling and provisioning. These are the key enablers of radio access points leading to multicellular interference. Further benefits of fifth generation will be discussed [5-13].



Figure.1 Cloud computing trends [14]

Energy efficiency is an important factor in the rapidly growing industry of information and communication technology. The use of information and communication technology is increasing day by day which is accelerating the energy consumption. Cloud computing can be fundamentally energy efficient technology for information and communication technology shown in figure.1. This paper

identifies some of the key researches and challenges faced by this technology in extending the techniques to save energy. Cloud computing has turned into an extra ordinary adaptable, on request and progressively versatile processing framework for many applications. Cloud computing additionally exhibits an extra ordinary pattern and it is now clear that it is reshaping data innovation forms. Some of the major advantages are as follows.

1. Cost saving.
2. Ease in availability.
3. Ease in scalability

A. How does it work:

To comprehend the activities, it is simpler to divide it into two segments the front end and the back end. The front is the side of pc, client or customer. The backend is “The Cloud” segment of the framework. The front end comprises of the customers pc. Likewise, the application basic to get to the cloud computing framework. Towards the back of cloud innovation framework, there are different pc server and information frameworks that makeup the cloud. A distributed computing framework could possibly incorporate

For a growing business with a need of fluctuating bandwidth cloud services are ideal. The cloud capacity is easy to be increased or decreased. The IT directors, ranks “operational agility” as a top driver for cloud adoption shown in figure.2.

2. Capital costing:

Cloud computing decreases the high cost of the hardware’s demanded instead. You can easily pay a subscription charge that is in comparison much lower and which is favorable to your cash flow. It eases up the transfer of data. It makes your project look friendlier although it’s not easy to take first step of cloud adoption.

3. Portability:

With the help of cloud computing it is easy to access files or data from another place. If you have got an internet connection, you can do your work anytime from anywhere with the help of cloud computing applications. Further some of these applications do not restrict to a single platform.

4. Safety & Security:

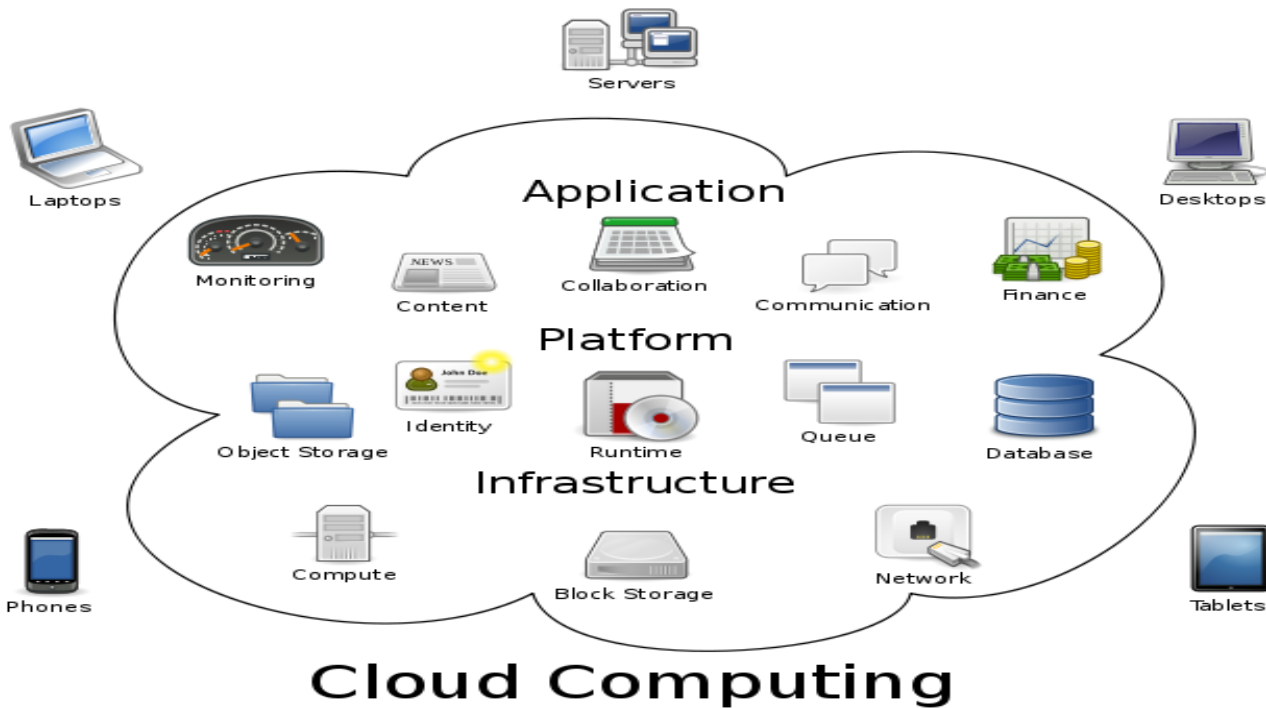


Figure.2 Cloud computing infrastructure [17]

any pc program, every application will have its own committed server.

B. Why Cloud Computing:

1. Flexibility:

For a businessman it is a great loss to lose his laptop or mobile phone which can cause a great loss of data. By the help of cloud computing your data is saved from being lost because your data is stored on to a virtual storage which is known as a cloud. You can easily remove your data from the lot device so that it cannot be misused and likewise you can retrieve it also. This can also help in location tracking.

5 Automatic updates:

In cloud computing it is a benefit that it automatically updates its security certificates and system updates. So the user do not have to take care of the system updates and wasting time on maintaining the system by himself.

6. Competiveness:

Transforming into cloud technology grants you an access to a whole new enterprise class world. In which a small scale business can act more efficient than a big scale business

II. LITERATURE REVIEW:

It includes Comparisons, Existing problems, their solutions and future directions.

A. *Security of cloud:*

Cloud security is a wide arrangement of advancements and controls set to ensure information and the foundation of cloud computing. It is undisputed that a large number of associations are being attracted to the cloud. Many of the IT associations have embraced “CLOUD FIRST” system for every new organization and will possibly consider the arrangements when the cost and innovation warrants a deviation from a cloud sending [18, 19].

In the view of this there are various difficulties in the security of robotization that each association must consider, while moving towards the cloud. The administrators on which we depend now days don't really mean that the threats will increase by the cloud. A few business and research association are not comfortable in totally believing the cloud computing for moving their important and highly secured data for the security reasons. The safety efforts taken by the cloud specialist's co-ops are commonly straight forward to the associations. The clients may be trusted by the CSP however they may be not be of trust to one another. Moreover many spywares and hackers often try to spike the data from the cloud by breaking the security protocols. [8]

B. *Why is the security of cloud important?*

Since cloud computing is being used widely, so the factor of its security have become the matter of high concern. Cloud computing has become a basic necessity of present day business with regards to keeping activities secure shown in figure.3. Since the data or the activities must be restricted to the concerned party that's why the security of cloud is a matter of great concern.

The cloud is being trusted widely and being used by many important organizations worldwide so the security of the cloud should be up to the mark and timely updated so that no intruder gets any access or interrupt is made. Companies are spending a great amount for the security of the data and high profile informations. Even the intelligence firms and agencies are also using the cloud. It looks easy of thinking that the data can easily be spiked from the cloud but on reality grounds the security is that much high that no one can break through.



Figure.3 Cloud computing secure data [20]

Cloud computing as previously discussed is being used widely in the corporate sectors in various fields some of those are going to be discussed below.

C. *SECTORS USING CLOUD:*

Cloud computing as previously discussed is being used widely in the corporate sectors in various fields some of those are going to be discussed below.

Integration of cloud computing and IOT:

The two fields of cloud and IOT have seen a fast and free development these universes are altogether different from each other and shockingly better, there qualities are regularly corresponding. Due to this act we are proposing people to join them.

IoT can profit by the essentially boundless abilities which are a great acid to cloud. Cloud can profit IoT by stretching its degree to manage genuine things in an appropriate manner. Cloud can give the middle of the road layer between the things and the application, concealing all the functionalities important to execute the last mentioned. [21, 22]

The security and privacy requirements should be focus considered. The cloud would easily comply with the protocol specifications there are three security targets that should be achieved [24, 25].

1. INPUT PRIVACY.
2. OUTPUT PRIVACY.
3. FUNCTION PRIVACY.

The table 1and 2 below exhibits the primary security and security dangers in cloud based IOT with the computing countermeasures. [9]

III. BIG DATA AND CLOUD COMPUTING:

Cloud computing and big data are linked with each other. Big data provides the capacity to utilize products figuring to process circulated inquiries shown in figure.4. It gives the user an access over numerous data set and return the resultant data set in convenient way. Cloud computing provides the fundamental mechanism using Hadoop, a class of scattered

information handling stages. Huge information sources from the cloud and web are stored in a platform and Table 1 complementary aspects of cloud and IOT [23]

There are certain security dangers existing in cloud computing, for example. Security, classification, accessibility and uprightness. Cloud sellers must make sure that

	IoT	Cloud
Displacement	Pervasive	Centralized
Reachability	Limited	Ubiquitous
Components	Real world things	Virtual resources
Computational capabilities	Limited	Virtually unlimited
Storage	Limited or none	Virtually unlimited
Role of the Internet	Point of convergence	Means for delivering services
Big data	Source	Means to manage

Table 2 Security threats analysis [26]

administration level understandings are met. They should use solid cryptography to encrypt the information in a cloud

Security threats	Countermeasure
Identity privacy	Pseudonym [4, 5, 9], group signature [5], connection anonymization [7, 13]
Location privacy	Pseudonym [4, 5, 9], one-way trapdoor permutation [6, 10]
Node compromise attack	Secret sharing [8, 10, 14], game theory [7], population dynamic model [10]
Layer removing/adding attack	Packet transmitting witness [9, 10, 13], aggregated transmission evidence [10]
Forward and backward security	Cryptographic one-way hash chain [4, 5]
Semi-trusted/malicious cloud security	(Fully) homomorphic encryption [11], zero knowledge proof [15]

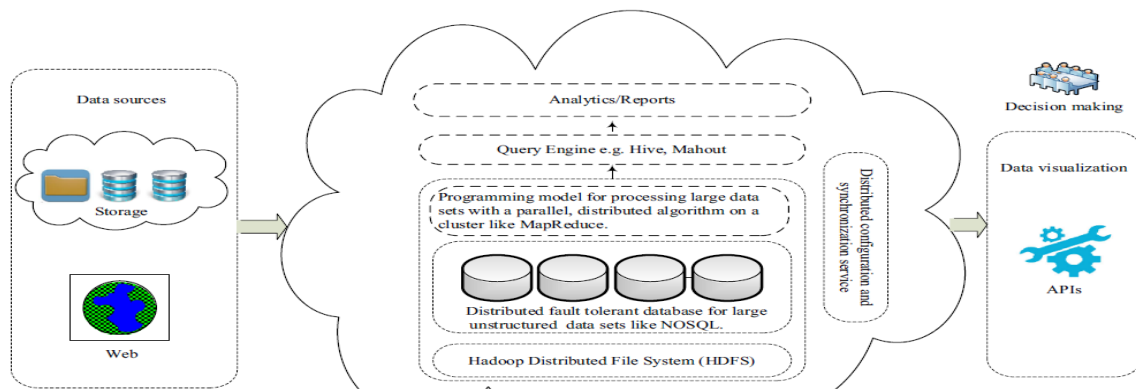


Figure.4 Cloud computing storage and APIs [27], computing environment [28, 29].

handled through a programming model for large data sets. The main purpose of information representation is to diagnose or overlook the outcomes of the decision making through different graphs. Big data can be signified in three main terms. Volume, Variety, Velocity. There are two more dimensions to be considered with respect to big data variability and complexity.

IV. MOBILE CLOUD COMPUTING & CLOUD'S IMPACT ON 5G NETWORKS:

Cell phones nowadays are equipped with a technology which expands computational power like control of processes, storage, stock piling and vitality. Cloud computing provides a

boundless ground to the cell phones to defeat the cell phones imperatives. This requires particular and appropriate cloud applications models mobile cloud computing is an advancement to cloud computing. In order to make mobile devices resourceful. Mobile cloud is based on two perspectives infrastructure and ad-hoc. Cloud is useful in storage and computing techniques which is of great use in the field of mobile cloud in Table 3. Mobile cloud is very useful as it can check the device location it can backup data so that if the device is lost no potential harm can be made to the data, due to advancements it can be of more potential.

as nodes for cloud computing if their owners allow to do so, like people who rent their large spare storage. For example There are many people who park their cars at the airports and travel for days their cars can be utilized by airport parking management system to store the data of the car entering and exiting the parking lots.

The security in vehicular cloud computing is very much necessary and of high concern. If someone breaches the security and get access to the vehicular cloud, then it can cause massive destruction and a great loss. He can control the traffic signals, the movement of vehicles. He can manipulate the data of the vehicles parked and can cause massive scale problem.

Table 3 Cloud and mobile computing comparison. [30]

Issues	Cloud Computing	Mobile Cloud Computing
Device energy	×	✓
Bandwidth utilization cost	×	✓
Network connectivity	×	✓
Mobility	×	✓
Context awareness	×	✓
Location awareness	×	✓
Bandwidth	×	✓
Security	✓	✓

In the field of mobile communication the fore coming advancement is the fifth generation networks. It enables a new and more competitive broadband services to provide high connectivity and data transfer rate. If the standards are met and the scenarios fit all the cases by the year 2020 the fifth generation mobile networks will occupy the dynamic market of mobile networking. Cloud technology is gaining more attention for the deployment of core mobile networks. In order to benefit from cloud technology network function virtualization (NFV) and software defined networking (SDN) is used. However, these approaches are not being applied yet in the consideration of radio access networks. The cloud-based design o radio access networks enable flexibility and adaptability in various perspectives [6].

Versatile cloud computing is really a blend of cloud computing and portable systems, in this manner, issues identifying with security can be partitioned into cloud security and portable system client’s security. There are many security threats to different mobile devices such as smart phones laptop etc. This can also cause privacy issues to the user. Some common security issues are mentioned below [10].

1. Data Ownership.
2. Data access and security.
3. Privacy.
4. Application Security.

V. VEHICULAR CLOUD COMPUTING:

Now a day’s use of vehicle is being increased at high rate, parking lots and main roads are full of cars. These cars can act

VI. DISCUSSIONS

From the research shared above it is clear that cloud computing in the modern world has become a great necessity and a helping part for almost every sector. Keeping in mind the advantages and benefits there are several drawbacks and some unwanted errors. Since it is a runtime system which is being accessed by many people at the same time so even a small error can cause great problem. In the cloud system there are important informations and data of high-profile companies and vulnerable agencies.

Since the cloud is holding so much of important data so the security of the cloud should be up to the mark and keenly checked. Since cloud is being used by the block chain systems and crypto currencies so if there is any interception it can cause a massive loss resulting in bankruptcy of the business associated. Since cloud is a virtual platform so it can be hacked or brought down.

Some of the drawbacks are listed below

1. Downtime:
Since cloud computing is based on the internet there is a chance of getting down and if the cloud is down it may cause a big loss to the company using it on real time.
2. Security and Privacy:
Since we are we are well aware of the hackers and the spywares present in the market. A company can hire a hacker to hack the cloud of the rival company for their own good.
3. Limited Control:

The users of the cloud have less control within a cloud hosted infrastructure which can retain him from the control of their application, services and data.

4. Cost:

The cloud systems are costly for a small scale business or a short term project. It may lower the hardware cost but because in cloud if you prevail it for a longer time so the end up cost may be greater.

We would like to end up our discussion on the basis that in the new world cloud is an emerging technology keeping in which all the areas of usage.

VII. CONCLUSION

Cloud computing have brought a revolutionary change in computing industry especially in virtual storage. Cloud computing have provided an efficient way of data storage and its access. Cloud computing is being used in many sectors like in vehicles, and Mobile networks. Many small business organization does not know about its proper use it can save large amount of money and time. Cloud's integration with Big Data and IOT also have high significance. Every things come with advantages and disadvantages it depends on the user on how he uses it. The security of cloud computing is still a question which is being asked by many of its users because it is being used on both high and low scales but the significance of the data stored is same, Any alteration in data or even if a single node is hacked it can cause a big damage.. Since many real time system are using cloud so there is zero space for error. There is any communication line through which data is being entered if any of the node stops working and interruption occurs then it can cause large amount of data loss. Keeping all these things in mind cloud is still the technology which is yet to be worked on if proper error and security management is done then it is better than all the other storing techniques.

REFERENCES

- [1] N. Vallina-Rodriguez and J. Crowcroft, "Energy management techniques in modern mobile handsets," *IEEE Commun. Surveys & Tutorials*, vol. 99, pp. 1–20, 2012.
- [2] M. Satyanarayanan, P. Bahl, R. Caceres, and N. Davies, "The case for vm-based cloudlets in mobile computing," *IEEE Pervasive Computing*, vol. 8, no. 4, pp. 14–23, 2009.
- [3] C. Mascolo, "The power of mobile computing in a social era," *IEEE Internet Computing*, vol. 14, no. 6, pp. 76–79, 2010.
- [4] E. Barba, B. MacIntyre, and E. D. Mynatt, "Here we are! where are we? locating mixed reality in the age of the smartphone," *Proc. IEEE*, vol. 100, no. 4, pp. 929–936, 2012.
- [5] A. Wright, "Get smart," *Commun. ACM*, vol. 52, no. 1, pp. 15–16, 2009.
- [6] R. Kemp, N. Palmer, T. Kielmann, F. Seinstra, N. Drost, J. Maassen, and H. Bal, "eyidentify: Multimedia cyber foraging from a smartphone," in *Multimedia*, 2009. ISM'09. 11th IEEE International Symposium on. IEEE, 2009, pp. 392–399.
- [7] Amazon simple storage service. Accessed December 8th, 2011. [Online]. Available: <http://aws.amazon.com/s3/>
- [8] X. Yang, T. Pan, and J. Shen, "On 3g mobile e-commerce platform based on cloud computing," in *Ubi-media Computing (U-Media)*, 2010 3rd IEEE International Conference on. IEEE, 2010, pp. 198–201.
- [9] C. Doukas, T. Pliakas, and I. Maglogiannis, "Mobile healthcare information management utilizing cloud computing and android os," in *Engineering in Medicine and Biology Society (EMBC)*, 2010 Annual International Conference of the IEEE. IEEE, 2010, pp. 1037–1040.
- [10] HAN et al.: A SURVEY OF MOBILE CLOUD COMPUTING APPLICATION MODELS 411
- [11] W.-T. Tang, C.-M. Hu, and C.-Y. Hsu, "A mobile phone based homecare management system on the cloud," in *Biomedical Engineering and Informatics (BMEI)*, 2010 3rd International Conference on, vol. 6. IEEE, 2010, pp. 2442–2445.
- [12] R. Ferzli and I. Khalife, "Mobile cloud computing educational tool for image/video processing algorithms," in *Digital Signal Processing Workshop and IEEE Signal Processing Education Workshop (DSP/SPE)*, 2011 IEEE. IEEE, 2011, pp. 529–533.
- [13] W. Zhao, Y. Sun, and L. Dai, "Improving computer basis teaching through mobile communication and cloud computing technology," in *Advanced Computer Theory and Engineering (ICACTE)*, 2010 3rd International Conference on, vol. 1. IEEE, 2010, pp. V1–452.
- [14] Facebook. Accessed November 26th, 2011. [Online]. Available:<http://facebook.com>
- [15] <https://www.dataversity.net/cloud-architecture-cloud-computing-trends-2019/>
- [16] Flickr. Accessed December 26th, 2011. [Online]. Available: <http://flickr.com>
- [17] V. S. Pendyala and J. Holliday, "Performing intelligent mobile searches in the cloud using semantic technologies," in *Granular Computing (GrC)*, 2010 IEEE International Conference on. IEEE, 2010, pp. 381–386.
- [18] <https://www.fastmetrics.com/blog/wp-content/uploads/2014/10/how-cloud-computing-works.png>
- [19] G. Huerta-Canepa and D. Lee, "A virtual cloud computing provider for mobile devices," in *Proc. 1st ACM Workshop on Mobile Cloud Computing & Services: Social Networks and Beyond*. ACM, 2010, p. 6.
- [20] T. Xing, D. Huang, S. Ata, and D. Medhi, "Mobicloud: A geodistributed mobile cloud computing platform," in *Network and Service Management (CNSM)*, 2012 8th International Conference on. IEEE, 2012, pp. 164–168.
- [21] <http://www.smbnation.com/content/news/cloud-computing-security-how-the-cloud-keeps-your-data-secure>
- [22] C. Wang, K. Ren, W. Lou, and J. Li, "Toward publicly auditable secure cloud data storage services," *IEEE Network*, vol. 24, no. 4, pp. 19–24, 2010.
- [23] F. Chang, J. Dean, S. Ghemawat, W. C. Hsieh, D. A. Wallach, M. Burrows, T. Chandra, A. Fikes, and R. E. Gruber, "Bigtable: A distributed storage system for structured data," *ACM Trans. Computer Systems (TOCS)*, vol. 26, no. 2, p. 4, 2008.
- [24] Stergiou, Christos, et al. "Secure integration of IoT and cloud computing." *Future Generation Computer Systems* 78 (2018): 964–975.
- [25] X. Fan, J. Cao, and H. Mao, "A survey of mobile cloud computing," *ZTE Communications*, vol. 9, no. 1, pp. 4–8, 2011. [
- [26] E. E. Marinelli, "Hyrax: cloud computing on mobile devices using mapreduce," *DTIC Document*, Tech. Rep., 2009.
- [27] Zhou, J., Cao, Z., Dong, X., & Vasilakos, A. V. (2017). Security and Privacy for Cloud-Based IoT: Challenges. *IEEE Communications Magazine*, 55(1), 26–33. doi:10.1109/mcom.2017.1600363cm url to share this paper: sci-hub.tw/10.1109/MCOM.2017.1600363CM

- [27] <https://ars.els-cdn.com/content/image/1-s2.0-S0306437914001288-gr3.sml>
- [28] L. Guan, X. Ke, M. Song, and J. Song, "A survey of research on mobile cloud computing," in Computer and Information Science (ICIS), 2011 IEEE/ACIS 10th International Conference on. IEEE, 2011, pp. 387– 392.
- [29] D. Kovachev, Y. Cao, and R. Klamma, "Mobile cloud computing: a comparison of application models," arXiv preprint arXiv:1107.4940, 2011.
- [30] Othman, Mazliza, Sajjad Ahmad Madani, and Samee Ullah Khan. "A survey of mobile cloud computing application models." IEEE Communications Surveys & Tutorials 16.1 (2013): 393-413.