ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

NIST: Model for Enabling Ubiquitous, Convenient, On-Demand Access for Cloud Resources

E.Tabitha[1], S.Rajeswar[2]

M.Tech, Department of Software Engineering, Arjun College of Technology and Science, Batasingaram, Rangareddy, Hyderabad, Telangana, India

Associate Professer & HOD, Department of CSE, Arjun College of Technology and Science, Batasingaram, Rangareddy, Hyderabad, Telangana, India

ABSTRACT: Cloud computing is a recent and fast growing area of development in healthcare. Ubiquitous, on-demand access to virtually endless resources in combination with a pay-per-use model allow for new ways of developing, delivering and using services. Cloud computing is often used in an "OMICS-context", e.g. for computing in genomics, proteomics and molecular medicine, while other field of application still seem to be underrepresented. Thus, the objective of this scoping review was to identify the current state and hot topics in research on cloud computing in healthcare beyond this traditional domain. Even though cloud computing in healthcare is of growing interest only few successful implementations yet exist and many papers just use the term "cloud" synonymously for "using virtual machines" or "web-based" with no described benefit of the cloud paradigm. The biggest threat to the adoption in the healthcare domain is caused by involving external cloud partners: many issues of data safety and security are still to be solved. Until then, cloud computing is favored more for singular, individual features such as elasticity, pay-per-use and broad network access, rather than as cloud paradigm on its own.

KEYWORDS: Omics, Domain, Cloud Computing,Nist,On-Demand, Hipaa, Information Systems.

I. INTRODUCTION

Cloud computing seems a viable solution to fulfill these demands. Commercial providers like Amazon and Microsoft promise to make hundreds of virtual machines available at ones' fingertips, almost immediately and just for the time they are really needed. The advantage of such offers is, that such resources only have to be paid for the configuration, size and time they are actually used. Thus, the term "cloud computing" is described by the National Institutes of Standards and Technology (NIST) [2] as a model for enabling ubiquitous, convenient, on-demand access to a shared pool of configurable computing resources. As essential characteristics of cloud computing Mell and Grance have listed (1) on demand self-service, (2) broad network access, (3) resource pooling with other tenants, (4) rapid elasticity, and (5) measured services. Clouds promise advantages in dynamic resources like computing power or storage capacities, ubiquitous access to resources at anytime from any place, and high flexibility and scalability of resources. These benefits have been the reason for increasing adoption of cloud computing in many business areas. In recent years this concept has seemingly also been introduced in the healthcare domain. At least, a continuously increasing number of articles and publications appears in the popular literature and is provided by healthcare IT companies, but also in the scientific literature cloud computing for healthcare applications is gaining attention.

When reviewing the large amount of most recent literature dealing with cloud approaches in healthcare it becomes obvious, that many reports are dealing with cloud-computing technologies as a replacement for grid computing in the OMICS-field, while other fields of application (e.g. health information systems, health information exchange or image processing and management) still seem to be underrepresented. In the popular literature the application of cloud computing for healthcare information system provision for example is often used as a buzz word, but real evidence on

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

research in healthcare cloud computing (beside the big topic of OMICS) or even its successful and resource saving application is missing. Researchers have proposed cloud computing as a new business paradigm for biomedical information sharing [3]. Kuo asked "if cloud computing can benefit health services" [4] and described opportunities and challenges of healthcare cloud computing [5]. Ahuja and colleagues have recently tried to survey the current state of cloud computing in the healthcare domain [6]. However, their overview has by far neither been representative nor comprehensive (many of their limited number of 27 references were company website information or publications with a commercial background). Thus, since currently no real overview on the application of cloud computing in healthcare exists, it is the objective of our scoping literature review, to uncover the current myth on healthcare cloud computing. It is our aim to provide a comprehensive overview on the existing literature and elicit the key messages of the current publications.

Categorization of cloud computing research in healthcare:
main domains The final list of papers was screened again to identify any new topic complementing the MEDLINE result list. Each two reviewers independently tagged the articles in the qualitative synthesis with main domains included in the papers. The final set of topics was discussed by all reviewers and similar topics were grouped to one main topic. Finally the following six domains for the application of cloud computing to healthcare, sorted in descending order by the number of included articles, were identified :
1. Telemedicine/Teleconsultation
2. Medical Imaging
3. Public health and patients' self-management
4. Hospital management/clinical information systems
5. Therapy
6. Secondary use of data

II. IMPLEMENTATION

1) Telemedicine/teleconsultation:-

Supporting communication and sharing data among stakeholders in healthcare is the most prominent domain including 34 articles. However, most publications describe just a typical telemedicine application when they report on the possibility to ubiquitously collect, access and share or analyze patient data from different hospitals or healthcare providers in dedicated health services networks.

2) Medical imaging:-

One of the second largest domains of use with 15 articles is medical imaging focusing on the storage, sharing and computation of images. Kakadis [23] provides a more theoretical description of various aspects of cloud computing with a special focus on medical imaging. Computing intensive image processing, sharing/workflows and archiving are the three major application areas, security the major challenge. As a visionary paper it remains on a conceptual level and does not explicitly refer to implementations. Similarly, Gerard also motivates the utilization of cloud technologies in Griebel et al. BMC Medical Informatics and Decision Making (2015) 15:17 Page 6 of 16 radiology in his extended outlook, if adequate service level agreements are in place to guarantee uptime and performance and security is granted [24]. A cloud-based Picture Archiving and Communication System (PACS) might enable the storage of medical images as "PACS-as-a-Service" [25] or even provide a highly flexible "radiology round-the-clock" [26]. Rostrom et al. [1] have built a proof-of-concept prototype to demonstrate that the secure exchange of images between a client and a DICOM server hosted in the Microsoft Azure cloud is possible. The development of a DICOM (Digital Imaging and Communications in Medicine) compliant bridge for easily sharing DICOM services across healthcare institutions supports the provision of medical imaging services across the different institutions [25,27].

3) Public health and patients' self-management:-

Public Health is concerned with prevention, health promotion or improvement for individual citizens and patients

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

but also for large population groups (epidemiology). Identically to the domain of medical imaging 15 articles belong to this domain. Several papers include the idea that cloud computing might be used to support citizens and patients in managing their health status. Botts et al. [36] describe a pilot study named HealthATM which is a cloud-based personal health infrastructure to provide individuals from underserved population groups (i.e. people without health insurance) with instant access to their health information. The authors see cloud computing as a way to provide broad access to health data to population groups but do not explain how this highly scalable cloud architecture was implemented in detail, because the main focus of the paper was on the acceptance and usability of a personal electronic health records system in underserved populations. The work of Piette et al. focusses on underserved patient groups as well. In two papers they describe how they created systems to inform underserved patient groups suffering from diabetes [37] resp. hypertension [38] with automated telephone calls to enable an improved self-management of the diseases.

4) Therapy:-

Seven papers describe applications for planning, managing or assessing therapeutic interventions. Chang et al. describe a website for access to information on drug compounds used in Traditional Chinese Medicine. In future, the iSMART portal shall provide genetic research features for drug research; however, until now only a webserver to the database exists publicly and no information on the cloud-specific development is given. Dixon et al. describe a prototype of a clinical decision support system (CDS) that packages a patient's data and sends it to a remote SaaS for analysis, i.e. rule application; a comparison of the local assessments versus the remotely generated results are analyzed in . While the service model for cloud computing seems fulfilled, no features of SaaS such as scalability or pay-peruse are mentioned. Another evaluation of a cloud-based decision support system for early recognition of sepsis is described by Amlad et al. An add-on to the Cerner EHR was used to continuously monitor patient to recognize possible outbreak of sepsis. While the system performed well, the added benefit of being cloud-based
is not described.

5) Hospital management and clinical information systems:-

Another interesting field of cloud computing in healthcare described by 13 articles is the deployment of clinical information systems into clouds. Commercial HIS vendors (compare e.g. the CSC Health Cloud [3]) have started to propagate new managed HIS services for their customers and also offer infrastructure as a service on a monthly payment basis. According to Low and Chen the selection of such an outsourcing provider needs to be evaluated very well. They proposed a provider selection evaluation model based on the Fuzzy Delphi Method (FDM) and the Fuzzy Analytic Hierarchy Process (FAHP) and identified decision criteria such as system usefulness, ease of use and reliability, high service quality or professionalism of the outsourcing provider . Yoo et al. have chosen a more conservative approach by establishing a private cloud within Seoul National University Bundang Hospital (Korea) based on virtualization technology, a virtual desktop infrastructure and 400 virtual machines, which supported easy and overall access to each of the hospital's information systems from all devices throughout the hospital. For this implementation they performed a five year cost-benefit analysis and showed that their approach reached its break-even point in the fourth year of the investment.

6) Secondary use of data:-

This domain includes articles describing cloud computing utilization for enabling secondary use of clinical data; e.g. for data analysis, text mining, or clinical research. Six papers belong to this domain. Regola and Chawla discuss possibilities to store and share research health data and data from electronic health records in a cloud structure to reach an HIPAA (Health Insurance Portability and Accountability Act) complying environment . For them, cloud computing offers the advantage of providing researchers with large computing resources. Data security can be achieved by providing proprietary cloud solutions where researchers can create their own customized networks and virtual servers. Similarly, Chard et al. describe an approach to enable cloud-based services which should offer high scalability and HIPAA-compliant data security. They propose a cloud-based Software-as-a-Service NLP prototype to enable the extraction, procession, management, and comparison of medical data from several hospitals. Nevertheless, it does not

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 7, July 2015

become clear how data security should be achieved as-at the moment-the data in this cloud is not anonymous yet, but shall be accessible only to the particular data provider.

7) Other domains:-

The main topic of some papers could not be assigned to one of the other categories. Doukas et al. describe an infrastructure for automated skin lesion classification to detect skin cancer in an early stage. This assessment system is based on mobile technologies used by patients–a cloud provides the essential data processing components for pattern recognition. Shen et al. implemented a cloud bio-signal (e.g. electroencephalography, electrocardiograph) analysis system but it hard to identify where exactly the cloud component can be found in their system architecture. Papakonstantinou et al. describe the prototype of a semantic wiki to support training in healthcare process management which allows cost savings, accelerated time to delivery, and offloaded maintenance. Second Live as a virtual environment is mentioned in two publications. Garcia-Penalvo et al. describe an interesting training environment for ongoing and already skilled pharmacists in virtual worlds. Their objective is that students and teachers get each an own avatar in the Second Life environment to practice and train laboratory work to assure a high education and work quality. In the authors' conceptual paper cloud computing is thought to support the mechanisms of data recovery and analysis to proper evaluate the processes in Second Life. Also Stoicu-Tivadar et al. propose a medical education approach based on the Second Life environment.

III. CONCLUSION

The aim of this review was to get an overview on the status of cloud-computing in healthcare and to identify areas of interest beyond typical "OMICS" topics. We found that especially resource intensive (e.g. medical imaging) and communication intensive areas such as various kinds of "tele-"applications are predestined for cloud computing use. It appeared to us, that many researchers do already declare their application as a cloud computing application, if only the two features of broad network access for data sharing among different stakeholders and data access from everywhere are given. Such type of applications, however, have already been implemented for a long time and–as long as the scenario has focused on supporting patient diagnostics and therapy–such approaches are typically named telemedicine applications, health information exchange or personal electronic health records.

In our opinion, an application which really enhances its provision by means of cloud computing should explicitly describe the cloud-specific characteristics of their application following the NIST definitions, such as rapid elasticity or measured service where a pay-per-use model supersedes upfront investments. Resource pooling helps organizations to consolidate and simplify infrastructure services and continue existing trends in virtualization. While in the consumer market on demand self-services are often used, in healthcare environments they only seem to play a minor role. Authors should also illustrate how this new technology/business model makes their application more cost effective than without cloud technology.

IV. FUTURE WORK

Further, if cloud computing is a major feature of a healthcare application, we recommend that in future publications, authors do describe the particular deployment model chosen (which often also relates to a description of data privacy measures applied, being very important for sensitive personal health data) and also which particular type of cloud service is applied. In too many of the recent publications those descriptions were missing and the impression remained, that authors often called a typical internet-/web-based telemedicine application now a cloud application, just because cloud computing is a current buzzword.

REFERENCES

1. Rostrom T, Teng CC. Secure communications for PACS in a cloud environment. Conf Proc IEEE Eng Med Biol Soc. 2011;2011:8219–22.
2. Mell P, Grance T. The NIST definition of cloud computing (draft). NIST Spec Publ. 2011;800(145):7.
3. Rosenthal A, Mork P, Li MH, Stanford J, Koester D, Reynolds P. Cloud computing: a new business paradigm for biomedical information sharing. J Biomed Inform. 2010;43(2):342–53.

4. Kuo M-H, Kushniruk A, Borycki E. Can cloud computing benefit health services?-a SWOT analysis. Stud Health Technol Inform. 2011;169:379–83.
5. Kuo AM. Opportunities and challenges of cloud computing to improve health care services. J Med Internet Res. 2011;13(3):e67.
6. Ahuja SP, Mani S, Zambrano J. A Survey of the State of Cloud Computing in Healthcare. Network Commun Technol. 2012;1:12–9.
7. Kondoh H, Teramoto K, Kawai T, Mochida M, Nishimura M. Development of the Regional EPR and PACS Sharing System on the Infrastructure of Cloud Computing Technology Controlled by Patient Identifier Cross Reference Manager. Stud Health Technol Inform. 2013;192:1073.
8. Shih FJ, Fan YW, Chiu CM, Shih FJ, Wang SS. The d lemma of "to be or not to be": developing electronically e-health & cloud computing documents for overseas transplant patients from Taiwan organ transplant health professionals' perspective. Transplant Proc. 2012;44(4):835–8.
9. Yu HJ, Lai HS, Chen KH, Chou HC, Wu JM, Dorjgochoo S, et al. A sharable cloud-based pancreaticoduodenectomy collaborative database for physicians: Emphasis on security and clinical rule supporting. Comput Methods Programs Biomed. 2013;111(2):488–97.
10. Rajkumar R. Dynamic Integration of Mobile JXTA with Cloud Computing for Emergency Rural Public Health Care. Osong Public Health Res Perspect. 2013;4(5):255–64.
11. Koufi V, Malamateniou F, Vassilacopoulos G. Ubiquitous access to cloud emergency medical services. In: Proceedings of the 2010 10th IEEE International Conference on Information Technology and Applications in Biomedicine (ITAB); The 10th IEEE International Conference on Information Technology and Applications in Biomedicine (ITAB); November 3-5, 2010; Corfu, Greece. New York, NY: IEEE; 2010.
12. Fujita H, Uchimura Y, Waki K, Omae K, Takeuchi I, Ohe K. Development and clinical study of mobile 12-lead electrocardiography based on cloud computing for cardiac emergency. Studies in health technology and informatics. 2013;192:1077.
13. Rao GSVRK, Sundararaman K, Parthasarathi J. Dhatri-A Pervasive Cloud initiative for primary healthcare services. In: Proceedings of the 2010 14th International Conference on Intelligence in Next Generation Networks (ICIN). Berlin, Germany: IEEE; 2010.
14. Al-Zaiti SS, Shusterman V, Carey MG. Novel technical solutions for wireless ECG transmission & analysis in the age of the internet cloud. J Electrocardiol. 2013;46(6):540–5.
15. Fong EM, Chung WY. Mobile cloud-computing-based healthcare service by noncontact ECG monitoring. Sensors (Basel, Switzerland). 2013;13(12):16451–73.
16. Wang X, Gui Q, Liu B, Jin Z, Chen Y. Enabling smart personalized healthcare: a hybrid mobile-cloud approach for ECG telemonitoring. IEEE J Biomed Health Inform. 2014;18(3):739–45.
17. Hsieh JC, Hsu MW. A cloud computing based 12-lead ECG telemedicine service. BMC Med Inform Decis Mak. 2012;12:77.
18. Hiden H, Woodman S, Watson P, Cala J. Developing cloud applications using the e-Science Central platform. Philos Trans A Math Phys Eng Sci. 2013;371(1983):20120085.
19. Cheng C, Stokes TH, Wang MD. caREMOTE: the design of a cancer reporting and monitoring telemedicine system for domestic care. Conf Proc IEEE Eng Med Biol Soc. 2011;2011:3168–71.
20. Hussain S, Bang JH, Han M, Ahmed MI, A min MB, Lee S, et al. Behavior Life Style Analysis for Mobile Sensory Data in Cloud Computing through MapReduce. Sensors (Basel, Switzerland). 2014;14(11):22001–20.
21. Almashaqbeh G, Hayajneh T, Vasilakos AV, Mohd BJ. QoS-aware health monitoring system using cloud-based WBANs. J Med Syst. 2014;38(10):121.
22. Zao JK, Gan TT, You CK, Chung CE, Wang YT, Rodriguez Mendez SJ, et al. Pervasive brain monitoring and data sharing based on multi-tier distributed computing and linked data technology. Front Hum Neurosci. 2014;8:370.
23. Kagadis GC, Kloukinas C, Moore K, Philbin J, Papadimitroulas P, Alexakos C,et al. Cloud computing in medical imaging. Med Phys. 2013;40(7):070901.
24. Gerard P, Kapadia N, Chang PT, Acharya J, Seiler M, Lefkovitz Z. Extended outlook: description, utilization, and daily applications of cloud technology in radiology. AJR Am J Roentgenol. 2013;201(6):W809–11.
25. Silva LA, Costa C, Oliveira JL. A PACS archive architecture supported on cloud services. Int J Comput Assist Radiol Surg. 2012;7(3):349–58.
26. Kharat AT, Safvi A, Thind S, Singh A. Cloud Computing for radiologists. Indian J Radiol Imaging. 2012;22(3):150–4.
27.Silva LA, Costa C, Oliveira JL. DICOM relay over the cloud. Int J ComputAssist Radiol Surg.2013;8(3):323–33.
28.Sofka M, Ralovich K, Zhang J, Zhou SK, Comaniciu D. Progressive data transmission for anatomical landmark detection in a cloud. Methods Inf Med. 2012;51(3):268–78.
29. Doukas C, Pliakas T, Maglogiannis I. Mobile healthcare information management utilizing Cloud Computing and Android OS. Conf Proc IEEE Eng Med Biol Soc. 2010;2010:1037–40.
30. Langer SG. Challenges for data storage in medical imaging research. J DigitImaging. 2011;24(2):203–7.
31. Maratt JD, Srinivasan RC, Dahl WJ, Schilling PL, Urquhart AG. Cloud-based preoperative planning for total hip arthroplasty: a study of accuracy, efficiency, and compliance. Orthopedics. 2012;35(8):682–6.
32. Yoshida H, Wu Y, Cai W, Brett B. Scalable, high-performance 3D imaging software platform: system architecture and application to virtual colonoscopy. Conf Proc IEEE Eng Med Biol Soc. 2012;2012:3994–7.
33. Qi X, Kim H, Xing F, Parashar M, Foran DJ, Yang L. The analysis of image feature robustness using cometcloud. J Pathol Inform. 2012;3:33.
34. Meng B, Pratx G, Xing L. Ultrafast and scalable cone-beam CT reconstruction using MapReduce in a cloud computing environment. Med Phys. 2011;38(12):6603–9.
35.Avila-Garcia MS, Trefethen AE, Brady M, Gleeson F, Goodman D, editors.Lowering the Barriers to Cancer Imaging. Proceeding of the 4th IEEE International Conference on eScience (eScience '08);7th –12thDec.2008: 63-70.
36. Botts NE, Horan TA, Thoms BP. HealthATM: personal health cyberinfrastructure for underserved populations. Am J Prev Med. 2011;40(5 Suppl 2):115–22.
37. Piette JD, Mendoza-Avelares MO, Ganser M, Mohamed M, Marinec N, Krishnan S. A preliminary study of a cloud-computing model for chronic illness self-care support in an underdeveloped country. Am J Prev Med. 2011;40(6):629–32.
38. Piette JD, Datwani H, Gaudioso S, Foster SM, Westphal J, Perry W, et al. Hypertension management using mobile technology and home blood pressure monitoring: results of a randomized trial in two low/middle-income countries. Telemed J E Health. 2012;18(8):613–20.
39. Takeuchi H, Mayuzumi Y, Kodama N, Sato K. Personal healthcare system using cloud computing. Stud Health Technol Inform. 2013;192:936.