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A Classification of Cloud Services and Their Security Assessment in the Healthcare Industry

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Abstract - The role of cloud-based services in healthcare settings is crucial in the 21st century. This paper discusses their advantages and tools in hospitals, clinics, and diagnostic centers, categorizing existing applications and services into data storage, computing power, networking, PaaS, SaaS, data analytics, business intelligence, and project management. It also provides an in-depth analysis of security and risk assessment issues in cloud-based services, supported by case studies. Additionally, it includes a comparative risk analysis diagram of secured versus non-secured cloud systems in healthcare. Finally, the paper concludes with recommendations for future work.

Key Words: Healthcare facilities, diagnostic centers, cloud services, information technology systems, security, risk analysis.

I. INTRODUCTION

Today, cloud computing permeates all aspects of human life, including marketing, education, and notably, healthcare. The significance of cloud services in healthcare is highlighted by the advancements in diagnostic tests and treatments, such as myopia laser surgery and CT scans, which were not possible before the 1990s. These clinical procedures necessitate extensive storage of patient data (e.g., ultrasound records) and require quick and easy access, which can only be provided by secure cloud systems. Without interactive cloud storage, hospitals and doctors would need vast amounts of external or portable disk storage. Thus, the contribution of cloud services to healthcare must be systematically analyzed in terms of benefits, tools, and risks. This study begins with a prototype classified analysis of the advantages and tools of cloud computing in healthcare (Section II). It then categorizes existing cloud-based applications and services (Section III), focuses on security issues (Section IV), and provides a risk analysis of healthcare cloud-based IT environments (Section VI). Case studies in Section V demonstrate the effectiveness of secure cloud computing in enhancing healthcare.

II. CLOUD BENEFITS AND EXISTING TOOLS AND SERVICES IN HEALTHCARE SECTOR

Cloud computing has several definitions in the literature, sharing common traits. Typically, a cloud: (a) is billed per usage, (b) offers flexible capacity resembling infinite resources, (c) provides a self-service interface, and (d) utilizes virtual resources. In healthcare, these characteristics translate into clinical, administrative, and financial benefits, facilitating collaboration among doctors, departments, and institutions. Cloud computing, along with AI and machine learning, enables robotic surgeries for conditions like prostate and breast cancer. Additionally, it eliminates the cost of maintaining physical servers by storing data in cloud databases. Table 1 summarizes the benefits (flexibility, scalability, patient safety, enhanced research, data interoperability) and tools of cloud computing in healthcare, revealing that cloud computing integrates existing technologies into a new ecosystem. This convergence of upgraded processors, virtualization, databases, and broadband networking reduces IT expenses in hospitals and diagnostic centers.

III. CATEGORIZATION OF CLOUD-BASED APPLICATIONS IN THE HEALTHCARE SECTOR

According to Digital Health Interventions (DHIs), cloud-based tools and services cater to patients, healthcare providers, health system managers, and data services. The cloud-based applications in healthcare are categorized under IaaS (Infrastructure as a Service) and SaaS (Software as a Service). IaaS includes storage, computing power, and network applications, while SaaS covers various clinical and non-clinical information systems.

Cloud services are provided on demand, with providers like Google, Microsoft, Salesforce, and Amazon maintaining the software, operating systems, and computing resources. SaaS is typically accessed through a web interface, contributing to quick provisioning, wide accessibility, proper project planning, communication, staff training, and transparency. Additionally, PaaS (Platform as a Service) is a distinct category that simplifies infrastructure complexity and maintenance.

a) Storage Applications:

These allow healthcare facilities to store data in local or cloud databases, providing online access to patients, doctors, relatives, and insurers. Popular storage applications include AWS, Elastic Block Storage (EBS), Rackspace Storage Cloud BI, Azure Premium Storage, Google Persistent Disks, Amazon S3, Rackspace Cloud Files, Azure Blob Storage, and Google Cloud Storage.

b) Computing Power Applications:

These services provide information about CPU, RAM, and I/O units, with pricing based on computing resources. Notable applications include Amazon EC2, Microsoft Azure Virtual Machines, and Google Cloud Compute Engine.

c) Network Applications:

These services, provided by public cloud providers, include Domain Name Servers and network load balancing. Applications such as AWS Elastic Load Balancer, Microsoft Azure Load Balancer, Google GPC Load Balancer, and Amazon Route 53 are used to distribute network traffic and manage incoming requests efficiently.

d) PaaS Applications:

PaaS platforms, which include pre-installed software stacks, simplify infrastructure complexity and maintenance. Examples include Digital MRI analysis, X-rays dashboards on Microsoft Azure, and Digital Pathology Systems for archiving slides.

e) Data Analytics and Business Intelligence Applications:

These applications help healthcare organizations process data and conduct statistical analyses to support business decisions. Notable software includes Domo, Sisense, and Geo-scatter for COVID-19 data visualization.

f) Applications of Data Integration (DI):

Cloud integration platforms enable healthcare organizations to consolidate data from various sources, such as remote monitoring devices for diabetes, into private or public cloud databases. Recommended tools for DI include SnapLogic, Information Builders, and Attunity.

g) Team Collaboration Applications:

Team collaboration applications fall into three main categories: (a) communication software, (b) task management software, and (c) document and content management software. Healthcare organizations should define a collaborative approach using SBAR tools, delegate roles and respect team members according to guidelines from the American or European Nurses Association, assign specific responsibilities based on Health Resources and Services Administration (HRSA) standards, and practice conflict resolution and effective teamwork.

h) CRM Applications:

Customer Relationship Management (CRM) applications are classified into: (a) Operational CRM, which allows medical representatives to efficiently store and retrieve interactions with doctors; (b) Analytical CRM, which analyzes data from Operational CRM to assess patient satisfaction with health services; and (c) Collaborative CRM, which uses tools such as faxes, phones, emails, and the web to interact with customers (doctors, patients, nurses). Examples include Salesforce Health Cloud, Healthgrades Healthcare CRM, Freshsales, Pega Customer Service for Healthcare, Telehealth, and Influx MD.

i) Project Management Applications:

Project management tools are divided into four categories: (a) internal business software, (b) personal software, (c) medium-sized systems, and (d) high-technology systems. Tools range from workflow-focused apps like Trello to comprehensive systems like Zoho Projects. The choice of application depends on the hospital or diagnostic center's management structure. For instance, Zapier integrates with over 600 other tools (e.g., Slack, Google Calendar, Xero, and Twilio). Essential task management programs include Asana, Monday, Insightly, Toodledo, and Allthings.

j) Applications for Office and Document Management:

Office and document management applications are categorized into: (a) web-based applications (Google Drive, Gmail), (b) client-server based applications (MS Outlook), (c) database packages (PostgreSQL), and (d) cloud-based packages (Carbonite for online backups). Web and cloud-based applications offer accessibility from anywhere, unlike client-server and database packages.

k) ERP Applications:

Enterprise Resource Planning (ERP) applications, though seemingly expensive, can be leased to reduce costs. Many healthcare companies rent cloud-based SaaS ERP applications. Leading providers include Evident, Harris Enterprise Resource Planning, Infor, Intacct, McKesson, Meditech, Oracle, Prognosis Innovation Healthcare, SAP, and Supply Chain. Clinics and diagnostic centers can customize ERP system user interfaces to enhance flexibility and agility.

l) HRM Applications:

Human Resource Management (HRM) applications are divided into: (a) Core HRM, focusing on benefits management, staff monitoring, and payroll; (b) strategic applications; and (c) workforce management applications. Core HRM tools include Omniprise HRM, Triton HR, and Epicor HR. Strategic tools include Sage HRMS, Lawson HR, and Ascentis, while workforce management tools include Halogen, Tribe HR, and Vista HRMS.

m) Clinic Applications:

Clinic applications include Telehealth, Electronic Health Records (EHR), and Picture Archiving and Communication Systems (PACS). Data integration allows clinicians to export comprehensive EHRs, covering allergies, end-of-life decisions, medications, and medical history.

IV. SECURITY AND RISK ASSESSMENT ISSUES IN HEALTHCARE CLOUD-BASED IT SYSTEMS

Adopting cloud services in the healthcare sector requires addressing significant security concerns. Major web-based threats include cyber-attacks and the limited technical knowledge of authorized users (doctors, nurses, and patients). Hackers often attempt to breach hospital cloud databases to install malware such as Trojans, worms, and viruses, aiming to delete or steal patients' personal data, violating General Data Protection Regulation (GDPR) rules. Additionally, hackers may surveil prominent doctors or critically ill patients. Solutions include robust access authentication with strong, varied passwords and strict authorization controls .

This section presents case studies demonstrating that effective security measures can enhance the efficiency of hospitals and clinics. A comprehensive risk analysis of these threats follows.

V. CASE STUDIES

GE Healthcare, known for its medical imaging equipment, handles daily healthcare data from over 500,000 devices. Before cloud adoption, up to 35% of patients were misdiagnosed due to insufficient multimedia data. Cloud computing has saved $30 billion annually . In June 2018, the International Data Corporation (IDC) reported global healthcare cloud computing expenditures of $10.8 billion . Servercloud Canada, a public health organization, achieved a flexible disaster recovery strategy and cost-effective high-quality service through nine web data centers across Canada . Concord Hospital improved the transfer of tomography and X-ray files with electronic medical records in the cloud, enabling remote infrastructure maintenance, automated backups, and error corrections, leading to significant IT budget savings.

VI. RISK ANALYSIS

This section identifies nine common threats in healthcare cloud computing and suggests measures to mitigate them. Security comparisons between secured and unsecured healthcare systems are presented highlights specific dangers (e.g., unauthorized access to patient data, compliance risks, service availability issues) within these nine categories .

a) Data Breaches: Unauthorized release of confidential data often occurs when patient data is shared across systems with varying security standards. GDPR forms typically inform patients of such breaches .

b) Data Loss: Occurs when data is no longer accessible to the owner or requesting application, either in storage or during network transmission .

c) Account Hijacking: Unauthorized takeover of a doctor's account for malicious purposes, often involving identity theft. Cloud security depends on the security of APIs, which, if improperly configured, can compromise the entire infrastructure .

d) Insecure Interfaces and APIs: The security of cloud services relies on secure software interfaces and APIs. Misconfigured security controls can expose the entire system to threats .

e) Denial-of-Service Attack (DoS): Attackers prevent legitimate users from accessing services by overwhelming the system with authentication requests from false addresses, causing servers to become unresponsive .

f) Malicious Insiders: Current or former employees, business partners, or contractors misuse access to negatively impact the organization's assets or information systems .

g) Abuse of Cloud Resources: Unauthorized use of cloud capabilities, often due to service providers losing control over their infrastructure, allowing attackers to exploit cloud services (e.g., repetitive free trials) .

h) Insufficient Due Diligence: Healthcare staff may lack knowledge of the cloud provider's environment, technology, and security threats. Employing cloud and security experts is essential to avoid unexpected issues .

i) Shared Technology Issues: Multi-tenancy in cloud computing allows shared resources among users, which can lead to data exposure if information is not encrypted throughout its transmission. For example, converting medical images online without secure encryption can expose sensitive data to hackers .

VII. CONCLUSIONS AND FUTURE WORK

This study concludes that cloud computing significantly advances IT in healthcare by providing universal access to the same cloud services for all hospitals and diagnostic centers. However, maintaining and continuously updating security measures for web transactions is crucial across all sectors, particularly healthcare, due to the constant emergence of new electronic threats. Under these conditions, cloud services can positively impact healthcare, enabling quicker, life-saving interventions.

This paper aids researchers by offering a clear categorization of cloud benefits and threats within the healthcare sector, along with numerous essential tools and applications. This enhanced information exchange and management saves time, a critical factor for implementing future trends. The future will likely see significant advancements with secure mobile apps and tools providing more capabilities. For example, devices such as diabetes and cholesterol monitoring watches, automated insulin belts, oxygen saturation monitors, portable oxygen masks, and heart rate monitors are expected to communicate with Android and iOS apps, which will then store collected data in cloud databases.

REFERENCES

[1] Douglas M. (2019) “Top 6 Benefits of Cloud Computing for Healthcare”, https://bit.ly/3aivmuj, Accessed on 24th February 2020

[2] Dhilawala A. “9 Benefits of Cloud Computing in Healthcare”, https://bit.ly/32IbzBN, Accessed on 24th February 2020

[3] Dr. Mehl G. and Tamrat T., https://bit.ly/2x3AWm0, Accessed on 24th February 2020

[4] Abrar H., Hussain S. J., Chaudhry J., Saleem K., Orgun M. A., Muhtadi J. A. and Valli C. (2018) “Risk Analysis of Cloud Sourcing in Healthcare and Public Health Industry”, https://bit.ly/38fEEWr, Accessed on 24th February 2020

[5] Calyptix (2016) “Top 5 Risks of Cloud Computing”, https://bit.ly/2x3zZKs, Accessed on 24th February 2020

[6] Computer Control Systems S.A., https://bit.ly/32JO6An, Accessed on 27th February 2020

[7] Sinhasane, S. (2019). Revolutionary Impact of Cloud Solutions on Healthcare. [Online] Gartner, Inc., https://gtnr.it/2PAcf79, Accessed on 27th February 2020

[8] Dhillon, B. (2015, December). Different Types of Cloud Computing Service Models. [Online] BluePi Consulting Pvt Ltd., https://bit.ly/2vAbkgb, Accessed on 2nd March 2020

[9] Garside W. and Cox B. "Big Data Storage for Dummies – A Wiley Brand", https://bit.ly/2VN9l2S, Accessed on 5th March 2020

[10] "Public Cloud Services Comparison", http://comparecloud.in/, Accessed on 5th March 2020
[11] Mellon L. (2017) "What is a Cloud Load Balancer?", https://bit.ly/3cr0kCi, Quantil, Accessed on 5th March 2020

[12] Gorelik, E. (2013). "Cloud computing models" Doctoral dissertation, Massachusetts Institute of Technology, https://cutt.ly/St3xZEP, Accessed on 6th March 2020

[13] Zola A. (2018) "How Healthcare Can Benefit from Data Integration", Intersog, https://bit.ly/3aAOtA3, Accessed on 6th March 2020

[14] King T. (2018) "Healthcare Data Integration: 5 Software Tools to Consider", Solutions Review, https://bit.ly/2TvLbZb, Accessed on 6th March 2020

[15] Spok (2019) "Infographic: How Healthcare Deploys Software as a Service (SaaS)", https://bit.ly/38uLcR4, Accessed on 6th March 2020

[16] Victoria S. (2018) "3 Types of Collaboration Software Tools to Improve Your Workflow", RubyGarage, https://bit.ly/2Irl7b3, Accessed on 6th March 2020

[17] Referral md, "4 Ways Medical Staff Can Collaborate More Effectively", https://bit.ly/39pmnaC, Accessed on 6th March 2020

[18] Diksha S. "Classification of CRM: 3 Types", Business Management Ideas, https://bit.ly/2uZ1X9z, Accessed on 6th March 2020

[19] Guay M. (2016) "The Best Project Management Software: 49 Tools for Team Task Management", Zapier, https://bit.ly/3aM8QKL, Accessed on 7th March 2020

[20] LaPointe J. (2017) "Top 10 Enterprise Resource Planning (ERP) Vendors By Hospital Use", Revcycle Intelligence, xtelligent Healthcare Media, https://bit.ly/2VTS5ck, Accessed on 7th March 2020

[21] Short T. (2020) "What is SaaS? 10 FAQs About Software as a Service", Software Advice, https://bit.ly/2TKhnH8, Accessed on 7th March 2020

[22] Mehraeen E., Ghazisaeedi M., Farzi J. and Mirshekari S. (2016) „Security Challenges in Healthcare Cloud Computing: A Systematic Review", Global journal of health science 9(3):157, https://bit.ly/2TvcpPm, Accessed on 7th March 2020

[23] AWS (2018) "GE Healthcare Launches Health Cloud on AWS, Improving Collaboration and Patient Outcomes", https://go.aws/3cIRLD6, Accessed on 9th March 2020

[24] Perry Y. (2018) "Cloud Computing in Healthcare with Cloud Volumes ONTAP", NettApp Inc., https://bit.ly/2ItBKD6, Accessed on 9th March 2020

[25] Servercloud Canada (2017) "Reliable, Secure & Compliant Disaster Recovery", https://bit.ly/2Qf88hh, Accessed on 9th March 2020

[26] Daymark Navigate Information Technology (2018) "Concord Hospital Case Study", https://bit.ly/2vQoPse, Accessed on 9th March 2020

[27] Phyrozz (2017) "History of Microsoft Windows (Windows 1.0 – 10)", https://cutt.ly/Lt98Rsk, Accessed on 16th April 2020

[28] Banerjee S. (2020) "An open-source code to analyze COVID-19 trends – Part I", towards data science, https://cutt.ly/Ot91xmY, Accessed on 16th April 2020

[29] "Chapter-4 CRM Strategies adopted by the Pharmaceutical Companies in India", https://cutt.ly/It95L9X, Accessed on 16th April 2020

[30] Chand R. D., Tripathi M. M. and Mishra S. K. (2016) "Cloud Computing for Medical Applications & Healthcare Delivery: Technology, Application, Security and SWOT Analysis", https://bit.ly/2UWdC2F, Accessed on 18th June 2020

[31] Haryani P. (2020) "Healthcare CRM Software: Top CRM Solutions For 2020", SelectHub Confidence in Software, https://bit.ly/3fD4ZBQ, Accessed on 18th June 2020

[32] Thriveni T. K. and Dr Prashanth C S R (2015) "Real-time threat prediction for cloud based assets using big-data analytics", https://bit.ly/2YgTbQ6, Accessed on 20th June 2020

[33] Kenton W. (2019) "Monte Carlo Simulation Definition", Financial Analysis, Investopedia, https://bit.ly/37KUwS8, Accessed on 20th June 2020

[34] Pitkas K. (2015) "Risk Management in Completion Projects of Informative Systems", Master Thesis, University of Piraeus, https://bit.ly/3dgSRVD, Accessed on 20th June 2020

[35] Ismail N. (2017) "The year of the cloud: flexible, agile and scalable", InformationAge, https://bit.ly/2YwW8Ml, Accessed on 25th June 2020

[36] PeekMed Blog – Orthopedics and healthcare technology (2019), "PACS Systems: Everything You Need to Know About them", https://bit.ly/2CJmceU, Accessed on 26th June 2020

[37] S. Mitropoulos and A. Veletsos, "A Categorization of Cloud-Based Services and their Security Analysis in the Healthcare Sector," 2020 5th South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference (SEEDA-CECNSM), Corfu, Greece, 2020, pp. 1-8, doi: 10.1109/SEEDA-CECNSM49515.2020.9221808.