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Survey Paper on Advancing Healthcare with Mobile Cloud Computing and Bigdata Analysis

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Abstract: The increasing use of mobile devices in people's daily lives facilitates the completion of several useful tasks. Mobile cloud computing enhances its benefits and gets over its limitations, such as memory, CPU power, and battery life constraints, by fusing mobile and cloud computing. Big data analytics tools allow value to be extracted from data that has four Vs: volume, variety, velocity, and veracity. This article discusses mobile cloud computing and big data analytics as they relate to networked healthcare. Together with the motivations underlying the development of networked healthcare systems and applications, the usage of cloud computing in healthcare is discussed. The paper discusses a mobile cloud computing infrastructure designed specifically for handling big data applications in the healthcare sector. This infrastructure is built on the concept of cloudlets, which are small-scale cloud data centers located closer to the end-users to enhance performance and reduce latency. The paper reviews various big data analytics methods, the necessary resources, and their applications within healthcare. Additionally, it draws conclusions about how to effectively design networked healthcare systems that leverage big data and mobile cloud computing technologies to improve healthcare services.

Keywords: Healthcare systems, Bigdata analytics, Mobile Cloud Computing, Bigdata, Cloudlet infrastructure, Healthcare applications

I. INTRODUCTION

The healthcare sector produces a vast amount ofdata about patients, medications, illnesses, treatments, research, and many other topics. Healthcare analytics have shown trends toward the digitization of all this data for patient care through record-keeping, compliance, and regulatory obligations. The term "healthcare big data" refers toall clinical data from clinical decision support systems (CDSS) and Computerized Physician OrderEntry (CPOE) systems. This includes electronic patient records (EPRs), machine-generated/sensordata from monitoring vital signs, prescriptions, medical imaging, lab, pharmacy, insurance, and other administrative data, as well as minimal patient care data from emergency departments, news feeds, and medical journals. Big data storage for healthcare holds the potential to lower costs while simultaneously enhancing quality. It may help with a number of medical and healthcare tasks, such as population health management, disease surveillance, and clinical decision support. Health data that is stored exclusively in the United States is said to have exceeded 150 exabytes in 2011 and may potentially reach zettabytes and yottabytes.

Because big analysis is so large, it ends up being the bottleneck. As a result, specialists in the healthcare field are turning to computer sciences to research and develop methods for converting data into knowledge and information. Emerging technologies in data science include Hadoop, natural language processing (where knowledge is taken from texts to enable computers to interpret human textual language), graph analytics, unsupervised learning (identifying hidden patterns in data), and others. The vast amounts of diverse data in the medical industry are currently surpassing the healthcare practitioners' intuitive ability. It is well acknowledged that algorithms are necessary to establish correlations between all of the related variables and characteristics. Therefore, there is a huge opportunity to advance medicine as an information science and establish the groundwork for the learning healthcare system (LHS) [1].

Another modern technology is cloud computing ,which gives users access to stored data at any time and from any location and for a variety of purposes in organizations or by individuals to lower costs, raise performance, and improve

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productivity NIST defines "a model for enabling ubiquitous, convenient, on-demand network access" as a shared pool of reconfigurable computing resources (such as networks, servers, storage, apps, and services) that can be quickly provisioned and released with little management work or service provider interaction. [2]

A combination of two small devices and remote system clouds called mobile cloud computing. Furthermore, mobile cloud computing is created by combining mobile devices with cloud computing to take use of the limitless services offered by the cloud via the mobile device. Cloud computing is dependent on a number of resources connected to a network that are shared to the fullest extent possible, minimizing administration and capital expenses.

The cloud-healthcare systems industry is one of the numerous industries that will profit from mobile cloud computing, or MCC [3]. For instance, the MCC healthcare system was designed to record and process biological signals (such blood pressure and ECG) in real time from users who were spread out across multiple locales. Health data are synchronized with the healthcare cloud computing service for storage and analysis, and a personalized healthcare application is installed on the mobile.

Big Data platforms and mobile cloud storage are connected by the anticipated paradigm for continuous information diversity, the capacity to produce knowledge effectively, adaptable inquiry, and helpful understanding of the implications of analysis. There are growth elements that impact our health equally as much. In this strategy, researchers, professionals, and patients are instructed to combat illnesses in opposition to each other. The projected model for continuous information variety, effective information generation ability, diverse inquiry, and helpful insight into the influence of analysis unites mobile cloud storage and big data platforms. In this strategy, researchers, professionals, and patients are instructed to combat illnesses in opposition to each other.

For example, environmental change will have an impact on people's health. Not the same Certain news can affect people emotionally and have an impact on their general health by changing their blood pressure. Among other factors, hereditary traits have a major influence in illness and infection barriers. When choosing a patient's medication, genetic information is also beneficial. Effective Health Care Analytics requires the wide-scale structuring of complex knowledge structures. This research aims to innovate a broad field of health care analytics. Big Data Platform and mobile cloud storage are combined for constant information of variety, effective information generation capacity, adaptable research, and practical understanding of the analysis's influence. In this strategy, researchers, professionals, and patients are instructed to combat illnesses in opposition to each other.

II. BIG DATA ANALYTICS IN HEALTHCARE SYSTEMS

Big data frequently has high values for volume, velocity, variety, variability, value, complexity, and sparseness. There are possible uses for big data. In the field of medicine, such as community health management, clinical decision support, epidemic control, disease surveillance, etc. [2].

Bigdata in healthcare can have a lot of advantages, such as early disease detection. Bigdata analytics adds new electronic and mobile health to smart healthcare systems, resulting in cost savings and increased efficiency. With the aid of cutting-edge information technology, bigdata in healthcare can be collected, enabling the investigation of information to enhance policymaking. Research on population aging and medical costs can be conducted with a life table, which offers proof for formulation of policy. The aging of the population also results in rising healthcare expenses. Big Data technologies are already being used in Japan to enhance senior citizen's healthcare and medical care.[4]

III. HEALTHCARE MOBILE CLOUD COMPUTING

Mobile devices have started to proliferate in numerous healthcare applications in recent years. The growing popularity of mobile computing can be attributed to its capacity to offer a tool to the user at any time and from any location, hence facilitating location-awareness. Nevertheless, it has certain intrinsic issues, like finite battery life of mobile devices, restricted software application availability, scarce resource in embedded devices, limited scalability of users and devices, and frequent disconnection. Because of the enormous volume, extreme complexity, and quick creation of healthcare data, these constraints have a greater impact in the healthcare business.[5]

Numerous mobile cloud computing infrastructures are available for various purposes, including applications related to healthcare. The conventional infrastructures entail a collection of cloud resources that, as seen in Figure , users of various device types may access remotely via the Internet[5].

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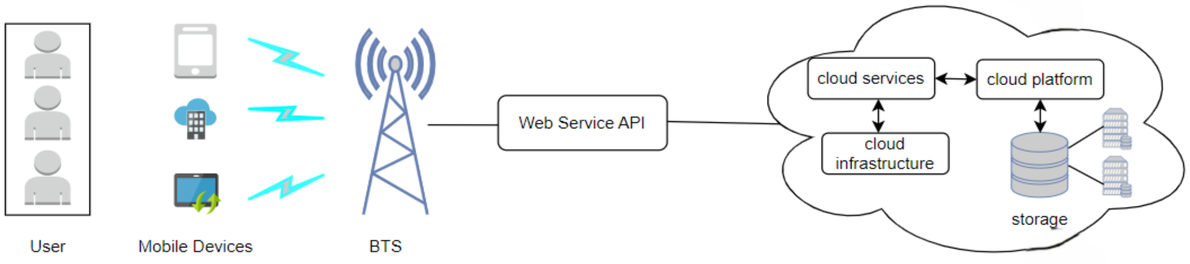

Figure 1: Mobile Cloud Computing Infrastruture for Health Care

With the extensive use of mobile applications in daily life, managing and analyzing the large amounts of data generated is essential to reduce both time and energy consumption. This need drives the creation of new and competitive Mobile Cloud Computing (MCC) models alongside traditional ones. A cloud can be envisioned as a nearby cloud, offering several advantages and overcoming some limitations associated with distant clouds. However, a cloudlet with limited resources might not be helpful and could even degrade performance. Consequently, the cloud let model, acting as an intermediary between the cloud and the mobile device, is considered to have significant potential for addressing issues related to Mobile Cloud Computing (MCC), such as latency and battery consumption.[6]

A proposal for a Cloudlet-based Performance Enhancement Framework was made in [8]. A closer cloud with several benefits and capacities to circumvent several constraints of a distant cloud is the cloudlet (figure). Thus, a restricted resources cloudlet won't be of assistance and could negatively affect performance. Therefore, it is thought that the cloudlet scheme, which is presented as a transitional layer between the cloud.

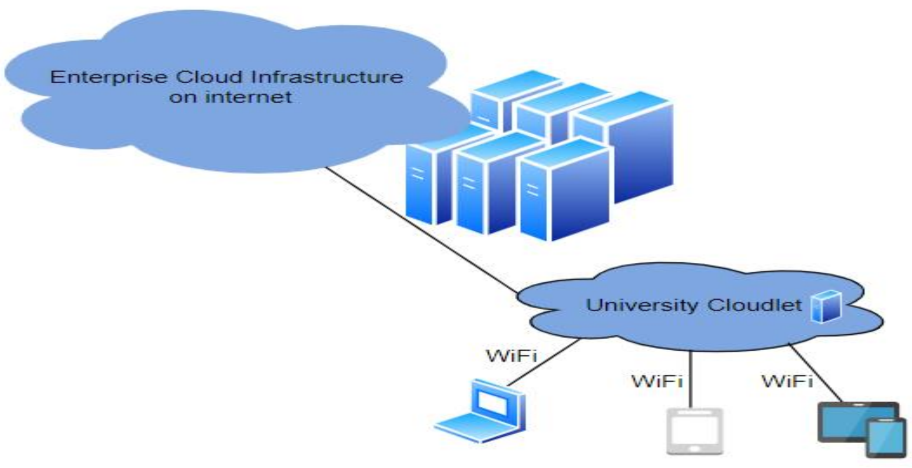

Figure 2: Cloud let concept

Therefore, it is highly likely that mobile devices can overcome challenges associated with Mobile Cloud Computing (MCC), such as power consumption and latency. However, there are instances where the mobile user is forced to connect straight to the EC. This occurs when the mobile device wants to request specific services that are not offered by the Cloudlet or needs to update files that are kept in the Enterprise Cloud. The authors developed a mobile cloud system with the cloud concept in mind for use in many settings, including academic institutions. Their system performs a variety of tasks using various sensors. They suggested and put into practice two primary applications for fire detection and traffic control, and a mobile cloud system processes sensor data. Within the same framework, the researcher presented an effective cloud let MCC model where mobile users speak with the cloud let directly rather than the organization. Their model can be used in a variety of settings, such as hospitals, where large volumes of data need to be processed and stored.

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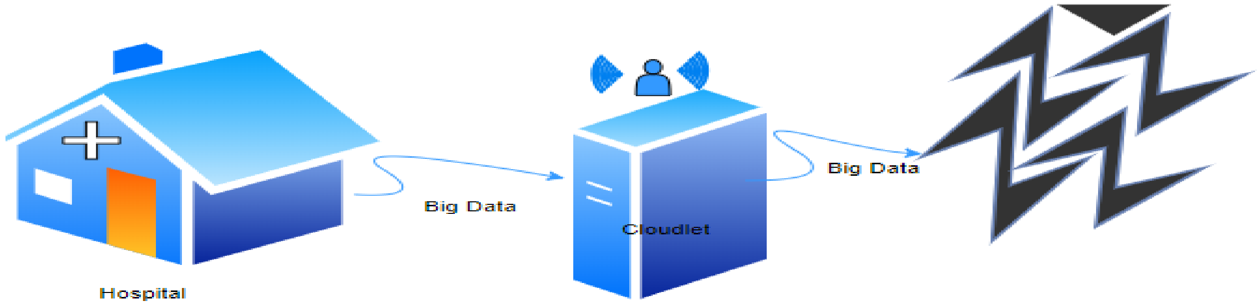

Figure 3: Healthcare bigdata in MCC

IV. BIG DATA IN HEALTHCARE SYSTEM

"Big data" refers to enormous amounts of data. Over time, the focus has shifted from the characteristics of these datasets with existing technologies to new technologies designed for fast data capture, discovery, and analysis. These technologies aim to extract value from large and diverse data sets efficiently. A widely accepted definition of big data is based on five key properties, known as the five Vs.

i. Volume (Managing extremely large amounts of data)
ii. Velocity (The speed at which data is collected.)
iii. Variety (Different forms of data, whether structured or unstructured, text, images, etc.)
iv. Veracity (The reliability and trustworthiness of data based on its origin, management, and processing)
v. Value (The goal of the entire system is to extract economic value from the data.)

This 5-V categorization emphasizes how strongly context-dependent big data is, which is characterized inherently in terms of particular applications (Value) and technological limitations (Volume, Velocity, Diversity, Truthfulness) [7]. The last 20 years have seen a great deal of innovation in data management tools and approaches due to these unique requirements, which by definition challenge the technologies that are currently available for Big Data. Cloud computing has also been essential in enabling these new distributed paradigms.

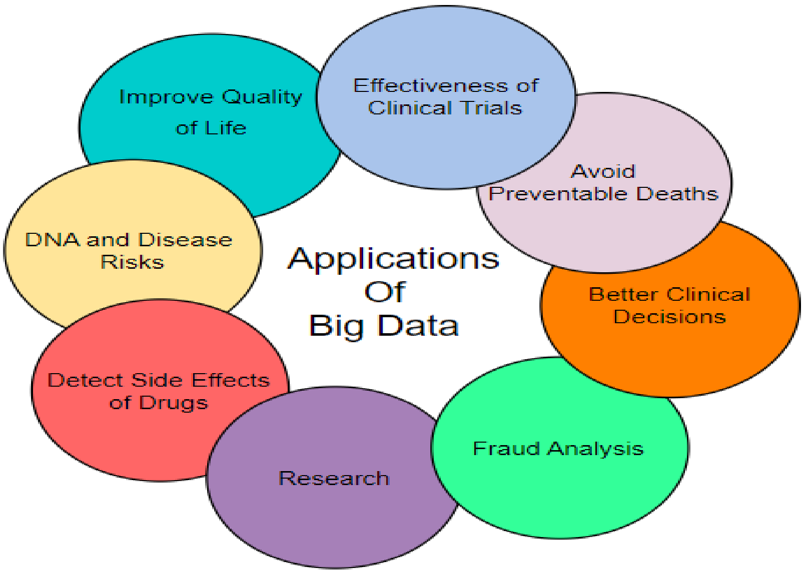

Figure 4: Applications of Big Data

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Progress in technology has led to an additional surge in data. In fact, real-time health monitoring systems for streams provide copious information of owing to the quick and substantial market penetration of personal devices, the advancement of wireless sensor and mobile communication technologies, and the generation of streamed data, both organized and unstructured [3].

Furthermore, clinical information on patients is generated by medical tests, imaging, and physician descriptions. This information is gathered through records that can take on a variety of formats and designations.[4]

V. RELATED WORK

The literature includes extensive research on cloud and mobile cloud computing and their practical applications in areas like finance and health. One paper introduces a secure cloud computing model based on data classification but overlooks the crucial issue of protecting users' private information in the cloud. This framework categorizes data by sensitivity and chooses the best encryption method to ensure each category receives the right level of security.

The authors proposed a prototype cloud-let architecture, listing the advantages of this approach for real-time applications. Using a forward approach, the cloud let it position itself in front of a wireless access point. Contrarily, with this prototype, a cloud let can be dynamically selected from within the network's resources to manage the apps currently operating on the component model. To reduce power consumption and network latency, especially for demanding workloads like multimedia applications, a large-scale Cloudlet MCC model was designed. Additionally, mobile customers can fulfill high-quality service requirements while traveling throughout the territory and utilizing cloud services remotely with lower broadband communication requirements thanks to the comprehensive implementation spanning regions [2,3].

The implications of integrating mobile cloud computing with cloud lets on a few interactive apps—such as streaming videos—were examined in early 2012. The authors compared and contrasted the two approaches in terms of system throughput and data transfer delay. Their results showed that, in most cases, the cloud let-based model outperformed the cloud-based model. A strategy for employing mobile cloud computing to provide personalized emotion-aware services was proposed in 2015[3].

VI. ADVANCEMENTS AND MOTIVATIONS IN NETWORKED HEALTHCARE

Advancements in genetic and molecular research show significant potential for personalized healthcare, but practical applications have yet to fully materialize. There are ongoing developments in knowledge management and product innovation within this field. However, the healthcare sector faces major challenges in fully leveraging Information and Communication Technology (ICT), primarily due to societal concerns regarding the privacy of health data and the trustworthiness of healthcare systems.

Looking ahead, healthcare executives are advised to focus on three key management strategies: fostering innovation, promoting open systems, and encouraging collaboration. These approaches are crucial for overcoming barriers and maximizing the benefits of ICT in healthcare.

Over the next decade, the integration of technologies like Health Information Exchange, Personal Health Records (PHRs), and Electronic Health Records (EHRs) is anticipated to drive significant advancements in health information technology. This evolution is driven by the pressing needs for improved access to high-quality care, addressing rising healthcare costs, enhancing system efficiency, reducing medical errors, and meeting the demands of an aging population who seeks more involvement in their health decisions.

In summary, while scientific progress holds promise for personalized medicine, addressing societal concerns and adopting effective management strategies will be pivotal in realizing the full potential of ICT in transforming healthcare delivery. A future for medical informatics is sketched in 2016. The authors claim that the adoption of technologies will facilitate the change of healthcare including bio-repositories and genomic information systems integrated with electronic health record (EHR) systems; Nanotechnology; Wearable technology; Health apps; Health information exchange with other industries/sectors like manufacturing and pharmaceuticals; Home-based telehealth solutions that link patients and healthcare providers; And medical robotics devices interfaced with health IT (HIT) systems[2].The US Department of Health and Human Services describes the accomplishments it has achieved in creating efficient treatment plans for critical illnesses, including diabetes, cancer, and heart attacks, as well as its vision for personalized healthcare. [4]In 2014, Apple announced Health Kit, a mobile health platform, and the cloud API for iOS 8.

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Apple's new venture with the Mayo Clinic and software supplier Epic Systems benefits Health Kit. Through the HealthKit API, users may access and share their PHRs through an interface.[2]

We will now review the literature on the studies of architecture and performance in the subject of networked healthcare, having already discussed the motivations for the system. Much research has been done on communication networks and distributed systems, such as cloud computing, regarding performance modeling and analysis. Three different types of healthcare organizations and four different classes of healthcare apps were considered in this study, which examined a range of organizational and application scenarios for grid deployment in networked healthcare.

The study provides a framework for examining the communication needs and computing requirements of healthcare apps. These requirements are particularly important because analytics applications, which need frequent and low-latency connections, are expected to generate a significant amount of traffic on future networks used by healthcare systems. Though each message might be small, the large number of messages will create substantial traffic. This pattern is similar to that seen in high-performance computing applications. Additionally, the study mentions a wireless sensor network-based system for healthcare monitoring.[2]

Continuous monitoring of physiological parameters is a crucial aspect of healthcare, significantly influencing the design of networks that connect sensors, analysis software, medical professionals, healthcare systems, and providers. For example, this research highlights the importance of tracking a pregnant woman's blood pressure, heart rate, and the fetus's heart rate and movement to insure her health is properly managed. Sensors attached to a patient's body create a wireless body sensor network, providing data on heart rate, blood pressure, and other health-related factors.[5]

When we talk about networked healthcare, we should bring up the Health Level Seven International standard. In 1987, HL7, a nonprofit organization, was established. The American National Standards Institute, or ANSI, who has accredited it, states that it is "committed to offering a thorough framework and associated standards for the interchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the administration, provision, and assessment of health services[2]". "Level Seven" describes the Open Systems Interconnection (OSI) seventh-layer communications paradigm, which is the application layer according to the International Organization for Standardization (ISO).

Many studies have explored networked systems and the quality of service (QoS) in data transfer across different networks, which is particularly important for medical applications. One study focused on modeling multimedia services over Wi-Fi networks, especially VoIP. It examined the end-to-end service modeling of multimedia (including text, voice, and video) through VoIP networks in metropolitan area network settings. Additionally, the paper introduced a unique analysis method that integrates Markov modeling with simulations.

A key advancement that will enhance future networked healthcare systems is integrating healthcare with other smart city systems. This means connecting healthcare operations with transportation and logistics systems, which can improve efficiency and resource sharing. For example, electronic health records (EHRs) can be linked with other smart city information systems. This integration allows for better coordination and utilization of resources across different sectors within a city.In the long term, networked healthcare systems will be part of larger city-wide networks that integrate information and operations across various services. This interconnected approach aims to optimize healthcare delivery and overall city management.

VII. HEALTHCARE APPLICATION SCENERIOS

The healthcare sector is a key driver of the Industry 4.0 (I4.0) vision, as demonstrated by market trends and scientific research. This vision enables healthcare applications in various settings, including Healthcare 4.0. Examples include tracking pathological and physiological indicators, self-monitoring, health prevention, medication intake tracking, and intelligent pharmaceuticals. Other applications are cloud-based systems for personalized health information, disease monitoring, telepathology, telemedicine, and rehabilitation in assisted living environments.

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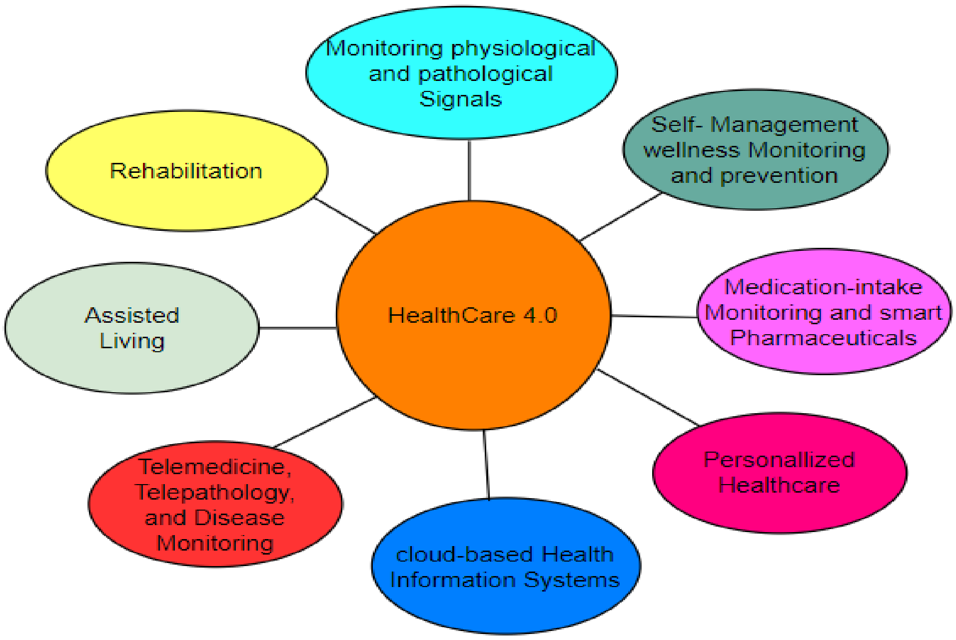

Figure 5: Main healthcare 4.0 Application scenarios

Figure 5: Primary Scenarios for Healthcare Applications. from acute medical rehabilitation programs to long- term senior care and home monitoring. New-generation big-data tools and architectures are needed to extract value from these settings, which enable high-velocity capture, discovery, and analysis of data, resulting in ever-larger volumes of diverse data . This is driving even more demand for a move to cloud architectures, which are necessary to handle processing and storage needs to evaluate data safely and dependably substantial volumes of data [7].

VIII. CONCLUSION

Mobile devices have become indispensable in daily life, enabling tasks like scheduling meetings, ordering food, and navigating in real-time. Mobile cloud computing enhances these devices by allowing them to handle intensive computing tasks that exceed their own capabilities. This approach saves energy and improves performance by leveraging cloud resources. In our research, we explore how big data analytics and mobile cloud computing support networked healthcare systems. These systems integrate cloud computing with healthcare applications, facilitating real-time analysis of vast amounts of patient data.

A mobile cloud computing architecture, centered on cloud lets, was proposed for healthcare big data applications. This architecture addresses the need for extensive computational resources and dynamic access to healthcare data, both within and beyond healthcare institutions. The integration of mobile and cloud technologies enables networked healthcare systems to manage and analyze massive datasets effectively, including patient records. This trend aligns with the broader integration of healthcare into smart city frameworks, fostering sustainable and efficient healthcare delivery. Future advancements in modeling techniques and high-performance computing will be crucial to developing practical networked healthcare systems that personalize medication, reduce costs, and enhance clinical procedures. Further research is needed to fully realize the potential of mobile cloud computing in healthcare applications.

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