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Cloud computing and 5G challenges and open issues

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ABSTRACT

The obtainable fourth-generation technology (4G) networks have been extensively used in the cloud application and are constantly evolving to match the needs of the future cloud applications. The fifth-generation (5G) networks are probable to immense expand today's cloud that can boost communication operations, cloud security, and network challenges and drive the cloud future to the edge and internet of things (IoT) applications. The existing cloud solutions are facing a number of challenges such as large number of connection of nodes, security, and new standards. This paper reviews the current research state-of-the-art of 5G cloud, key-enabling technologies, and current research trends and challenges in 5G along with cloud application.

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1. INTRODUCTION

Cloud computing (CC) is a general term for anything that involves delivering hosted services over the internet. Cloud providers are competing with each other and they constantly expand their services in order to differentiate themselves. CC is named as such because the information being accessed is found remotely in the cloud or a virtual space. CC has succeeded in bringing change in different fields of life. CC is a two-decade-old technology that works using the virtualizations rule. A virtual machine (VM) is one of the main elements of virtualization in CC that represents a physical server in the VM [1]. The evolution of fifth-generation (5G) networks is becoming available as a major driver of the growth of the internet of things (IoT) and cloud application applications. The 5G networks are expected to massive expand today's IoT and cloud that can boost cellular operation. The development of 5G will be based on the groundwork created by fourth-generation technology long-term evolution (4G LTE), which will provide user's voice, data, and the internet [2]. The 5G will significantly increase the talent and speed to offer dependable and speedy connectivity to the future cloud technology and IoT. 5G is the 5th development of cloud technology; the formal standard was customary in 2017 by the third generation partnership project (3GPP) to define the prerequisite of the 5G network, and the second phase of 5G, 3GPP release 16, is conventional to be released curtly [3].

2. CLOUD COMPUTING

In the past two decades, CC has progressed rapidly due to an increase in the user's demand and to ensure better services to the client. CC is considered a modern technology due to the equipment of elastics, flexible and on-demand storage for use. High computing and storage services can get any user and organization at a low cost without investing much in the infrastructure [4]. CC architecture comprises two main parts which are the front end and back end where different components in terms of storage, runtime, service, and security work in the back-end application and service work in the front end. Cloud architecture not only defines the components but also the relationship between them. These components are connected with the help of the internet [5].

According to Chang and Ramachandran, there are four types of CC that are used in different fields of life with specific rules and respective specifications [6]. Public cloud, this type of CC is connected to the data center and get resources from the data center and share these resources with different organization and user. It is not secure as private and is less expensive than private. Different organizations control and share the public cloud with a specific rule and management system [7]. A private cloud is designed for a single organization and is also known as the internal cloud. It is established within the organization or connected with a third party and it is more secure as compared to other types of computing. Private CC is established for the requirement of a third party or the demand of a third party. It is more secure and reliable due to the restriction and rules therefore it becomes more expensive than other types of CC [8]. Hybrid cloud it is the combination of public and private clouds with their respective strength and weaknesses. Organizations attempt to achieve the best from both types of the cloud and also known as the federation cloud. It is the intermediate between private and public because sometimes the user who uses the public cloud shift to the private cloud because they suddenly need more secure data. This process can be done with the help of the hybrid cloud [9]. Community cloud is a cloud service model which provides service to a limited number of individuals or organizations that are managed and secured by all participating organizations or a third-party managed service provider. Community clouds are a hybrid form of private clouds built and operated specifically for a targeted group. These communities have similar cloud requirements and their ultimate goal is to work together to achieve their business objectives [10], [11].

Each type of CC consists of different characteristic and a details explanation of CC characteristics are given in the next section. CC provides high availability and some benefits for every type of user in a different field [12]. Availability is one of the main pillars of an information system where it refers to the uptime of the system and network of systems where they collectively provide service during its usage. The traditional systems are limited on local installations when they shift into CC where the entire organization can use the available service of CC along with the end user [13]. When it is time for information and technology (IT) infrastructure for establishment then an organization decides on the bases of availability because it is the main key decision factor. Availability has been the major concern in distributed systems because highly available services in CC are the main element for the satisfaction of cloud users [14]. Scalability is the attribute that presents the ability of the software, network, and process of an organization to manage the increase in user demand. Normally scalability means frequent speed in CC in which the ability of a system or product to continue working after its context changes like volume or size to meet the user need. Scalability is a sign of stability and competitiveness which means the organization or network system is ready to handle the influx of demand according to changing needs and updates of the system.

Due to the property of scalability in CC lots of companies are shifting to CC [15], [16]. Cloud security is also known as CC security which consists of different policies, controls, procedures, and technologies that work together to protect cloud-based systems, data, and infrastructure from unauthorized access. Cloud security is a joint responsibility of the cloud provider and business owner or end-user. Security addresses both physical and logical issues in different models and layers [17]. Cloud automation is a broad term that refers to the processes tools and resources that are used by an organization to reduce manual efforts and is associated with managing CC workloads. It can be applied to different types of CC. Cloud automation is a fundamental building block for CC. It can be applied in a software layer where a complex system is used to configure and roll out the system balances for the network system. The aim is to make all activities related to computing as fast, efficient, and handoff as possible thought for the use of the various systems [18].

Virtualization is one of the main characteristics of CC which refers to as virtual rather than actual something. The virtualization concept was started in 1960 and early 1970 when International Business Machines Corporation (IBM) spent considerable time introducing more reliable and time-sharing technology. The step used for making VM is virtualization where the system runs on the operating system at a time and some resources are unutilized. For that reason, virtualization is used to make a multi-operating system with single physical resources. Nowadays physical resources are also used in virtualization systems [19]. Application layer. It consists of a cloud application that is used in a different field. It is the highest level of the hierarchy and works as an automatic scaling feature. The application layer defines the commands, responses, data types, and status reporting supported by the protocol. This layer is the only layer that directly connected or interacts with the end user. It provides different applications for user such as simple mail transfer protocol, file transfer, surfing the internet, chatting with friends, email clients, network data sharing, and various forms of file and data operations [20].

Platform layer, this layer consists of an operating system and application framework and sits on top of the infrastructure layer. The primary purpose of this layer is to minimize the burden of developing an application or reduce the complicity of development rule work under VM. Different application programming interface (API) and applications are used for storage data-based and logical web applications [21].

The infrastructure layer, this layer creates a pool of resources for storage computing resources with the help of a technology known as virtualization. It allows infrastructure as a service (IaaS) customer to create and discard VM and networks as per their business requirements. They pay for the services they consumed. IaaS removes the necessity for the consumer to invest in procuring and operating physical servers, data storage systems, and other networking resources [22].

Hardware layer, this layer is responsible for the management of all physical resources of CC which includes physical servicer, routers, switches, power, and cooling systems along with different resources. The hardware layer is typically implemented in the cloud data center where it consists of thousands of different physical resources and they are connected with different rules and regulations [23]. All layers are important due to their different operation and connectivity with each other. Different layers play an important role in CC.

However, this study only focuses on the platform layer because the development of CC requires the optimization of the different services of a different virtualized system. Therefore, the different researchers used load balancing techniques implemented in the platform layer of CC [24]. The platform layer is the important layer of CC because it includes different operating systems and software development frameworks that provide a resource to the end user [25]. In a few years, a CC has experienced remarkable growth in economic models and development models. All activities happened due to the platform layer of CC. Different virtualization systems are controlled and developed with the help of this layer because it deals with software and virtualization systems and VM are one of the main elements of this layer [26].

3. FIFTH-GENERATION (5G)

The evolution of 5G networks is becoming more readily available as a major driver of the growth of IoT and cloud application applications. The 5G networks are expected to massive expand today's IoT and cloud that can boost cellular operations. The development of 5G will be based on the groundwork created by 4G LTE, which will provide user voice, data, and the internet. The 5G will significantly increase the aptitude and speed to offer dependable and speedy connectivity to the future cloud technology and the IoT 5G is the 5^{th} invention of cloud technology; the formal standard was customary in December 2017 [27]. 3GPP to define the requirement of the 5G network, and the second phase of 5G, 3GPP Release 16, is predictable to be released shortly. The 5G network makes use of a high-band spectrum (referred to as millimeter-wave) for very high speed and low latency [28]. Table 1 presents the comparison of technologies.

Table 1. Comparison of recent generations of 5G network

Information	2G	3G	4G	5G
Year of introduction	1993	2001	2009	2018
Technology	Global system for mobile communications (GSM)	Wideband code-division multiple access (WCDMA)	Telecommunications engineering (TE), Worldwide interoperability for microwave access (WiMAX)	Multiple-input multiple-output (MIMO), Millimeter-wave (mmWave)
Access system	Time division multiple access (TDMA), code division multiple access (CDMA)	CDMA	CDMA	Orthogonal frequency division multiplexing (OFDM), beam division multiple access (BDMA)
Switching type	Circuit, packet	Circuit, packet	Packet	Packet
Network	Public switched telephone network (PSTN)	PSTN	Packet network	Internet
Internet service	Narrowband	Broadband	Ultra-broadband	Wireless world wide web
Bandwidth	25 megahertz (MHz)	25 MHz	150 MHz	30–300 gigahertz (GHz) [29]

By increasing the number of connected devices to internet, a high communication and computation capacity will be required to meet demands of future applications like, massive IoT and cloud applications requiring data sharing and processing. 5G will need to be efficiently maintain a larger and diverse set of devices. With the predictable rise of machine-to-machine communication, a single microcell may need to support 10,000 or more low-rate devices along with its established high-rate mobile users. This will require wholesale changes to the control plane and network management relative to 4G, whose overhead channels and state machines are not designed for such a diverse and large subscriber base [30]. Figure 1 presents the structure of 5G.

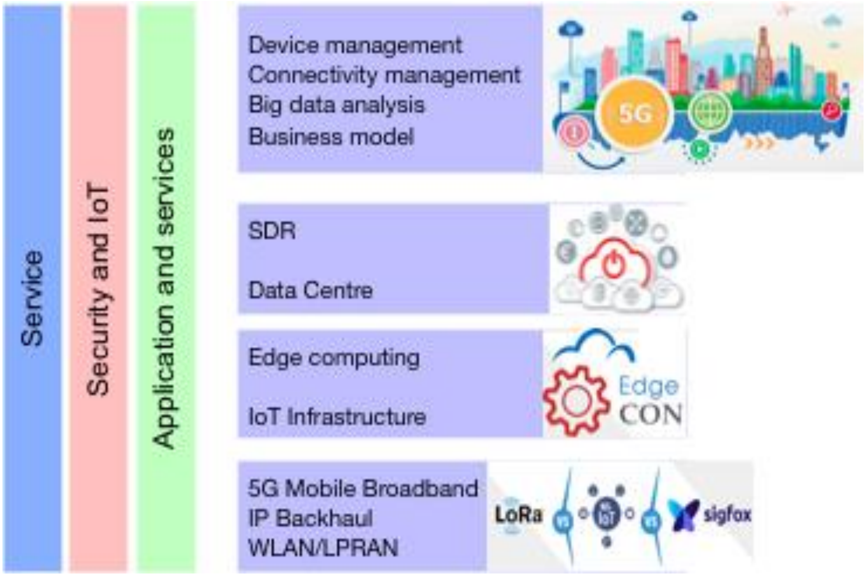

Figure 1. Architecture of 5G [31]

4. CHALLENGES AND OPEN ISSUES

In harmony with the increase in the computational require from the base stations, in the upcoming 5G networks, energy efficiency needs to be scaled up by 100–1,000 times in distinction with the established 4G network [32]. The transmission ranges would have been scaled down due the dense small cell operation the energy efficiency evaluation will potentially revolve around the computational side as compared to the transmission side previously. Scheduling schemes should be improved to involve a most favorable number of antennas and bandwidth for resource allocation in different technologies. The trade-off between spread and computational power should be optimized considering the effects of the kind of transmission technology involved. Software defined networking might be a latent fix for this issue, yet it needs further searching. Moreover, Wubben *et al.* [33] proposed the midway delays from source to destination to be included in the energy efficiency formulation for an even more practical inference [34].

5. FIFTH-GENERATION CLOUD ARCHITECTURE

The 5G cloud is anticipated to provide applications with real-time, on-demand, online, identifiable, and social experiences. Which requires the 5G-cloud architecture should be able to be end-to-end synchronized, featuring agile, automatic, and gifted operation during each phase [35]. Figure 2 presents the structure of 5G architecture based on the cloud.

The 5G-cloud architectures are expected to provide the as i) Provide logically independent networks according to requirements of applications and resource for different technologies; ii) Use cloud-based radio access network (RAN) to recreate RAN to provide gigantic connections of multiple standards and realize on-demand deployment of RAN functions, required by 5G [37]; iii) Simple core network architecture to implement on-demand configuration of network functions; iv) the architecture of the future global mobile telecom- medications, in which the 5G networks are expected to provide. Enhanced mobile broadband with cloud-based on 5G; and v) the ultra-reliable and low latency communications and massive machine type communications and services with different technologies [38].

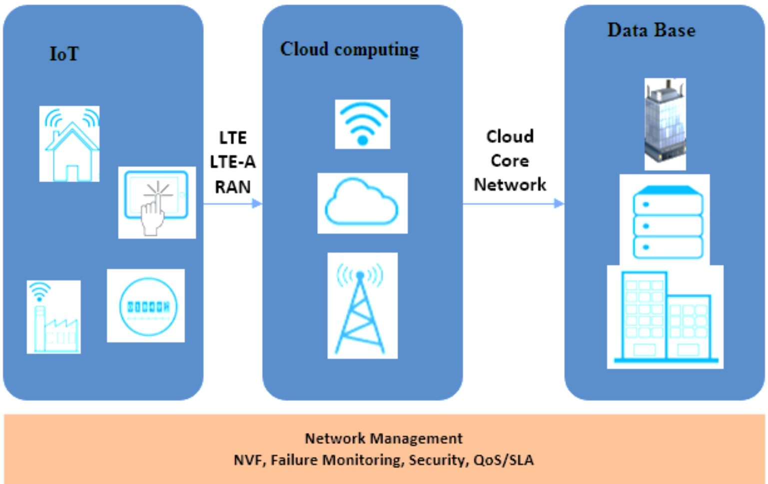

Figure 2. 5G architecture based on cloud [36]

6. CONCLUSION

In this paper, we provide review efforts in 5G-based cloud applications. The new studies touch on several paradigms like 5G, based cloud application, IoT, and edge computing. The paper presents information about 5G-based cloud applications and IoT-based applications where different standardization is discussed. In the last section of the paper, we present the structure of cloud applications and their role in upcoming applications along with future-based research.

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