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REVIEW IN CLOUD BASED NEXT GENERATION TELECOMMUNICATION NETWORK

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Graphical abstract

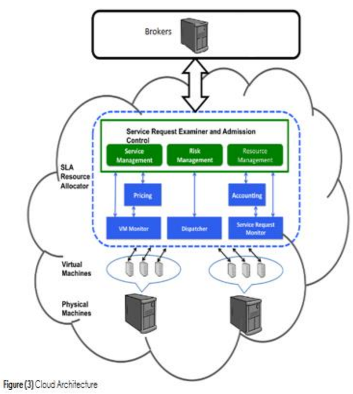

Figure (3) Cloud Architecture

Abstract

The development of cloud computing technologies is rapidly accelerating the integration of telecommunications services and the Internet, by adopting the cloud model the telecommunications industry can on demand ,organize and apply telecommunication resources as a services .The NGN (Next Generation Network), and IMS (intelligent multimedia subsystem) are essentially developed to provide multimedia services over an all-IP based network, however the full realization of both solutions is still is not reachable and it is still far from being widely deployed specially for the IMS, this is despite the development that has been undergoing for years .The main reasons behind that, is the increasing demands by consumers, fast evolving access technologies , complexity of implementations to meet these growing demands. Cloud computing as fast evolving IT paradigm can be considered as solution for scalability issue of NGN and IMS which may lead to the full realization of NGN and IMS .This Paper presents literature review on researches and trials on cloud based NGN and IMS.

Keywords: Cloud computing, IMS, Virtualization

1.0 INTRODUCTION

Cloud computing has become a trend in telecommunications development and has completely overturned the industry's traditional resource provision and user application modes Cloud computing came about when Internet businesses in their development stage were trying to accommodate large-scale resource deployment, and new emerging business models. [1] The large scale deployment of service resources required to fulfill the service large user's demands involves a huge capital expenditure and telecommunication operators have major concerns about sustaining a large scale service deployment. Thus, there are tremendous proposals have been introduced and cloud based novel solution as well, which reduces the initial cost of deployment and provides an easy way to scale the service with less expensive modification to the infrastructure. Integration of telecommunication services with cloud technology can change the legacy vertically-organized independent platform approach to construct a resource pool that has storage, network, computing and operation management capabilities [2].

1.1 Next Generation Network (NGN)

According to ITU-T [3] NGN is defined as "a packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies". According to ITU, NGN should provide unrestricted access to services based on user demand, supports generalized mobility, delivery reliable and ubiquitous services to users through Interworking via open interfaces and provides separation of control functions from the media [3].

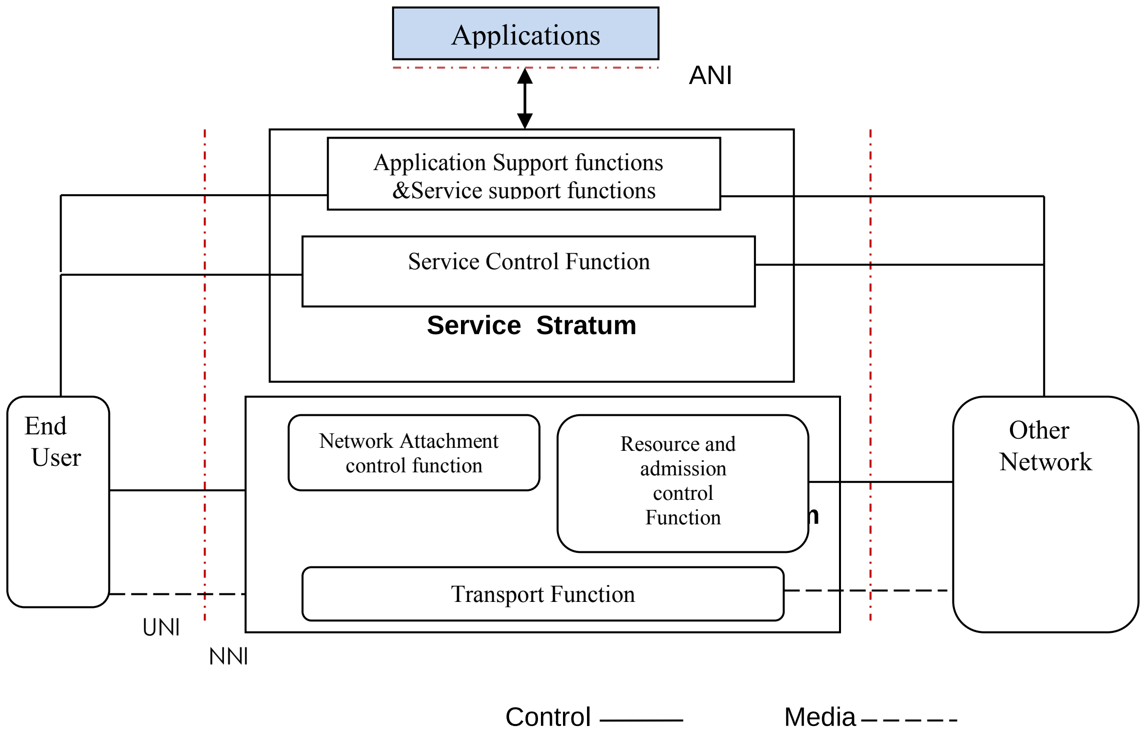

Figure 1 NGN architecture

ITU has defined NGN as a network consists of four function groups and two types of user profiles as depicted in Figure 1 [3]. Transport functions is used to transfer multimedia streams over the IP network while the transport control functions perform authentication tasks, assign IP addresses, and enable control functions such as resource admission for end to end QoS. On other side service control functions such as Intelligent multimedia subsystem (IMS), service support functions is used to provide support functions and application support function [3]. For the user profiles there are two types specified based on how user information is used by the transport control function and service Control function.

[3] for example the transport control function group may use the user profile to provide user authentication data and the bandwidth that the user may obtain to connects to the access network. The last one is the service user profile used by the service control function group. This profile includes information such as what services the user is allowed to use and number of simultaneous connections or any other supplementary services [3]. Regarding the user network interface ,ITU-T have identified three types of user-network interface (UNI), which is the connection point with end-user functions; the network-network interface (NNI), which is the connection point with other networks and the application-network interface (ANI), the connection point with application functions[3].NGN functional block diagram is shown below in Figure 1 [4]. More detailed description about NGN can be found in [4].

1.2 IP Multimedia Subsystem (IMS)

IMS was designed to deliver Internet Protocol based multimedia services to mobile subscribers. It was derived by the advancements in NGN developments. IMS specification was originally designed in release 5 standard by the 3rd Generation Partnership Project (3GPP) [2]. It enables cellular network operators to provision interactive multimedia services in cost effective manner by making use of core NGN IP networks. The Session Initiation Protocol (SIP) has been identified as signaling protocol for initiating and managing sessions in IMS [2]. Actually collaboration between 3GPP and the European Telecommunication Standard Institute (ETSI) has been taking place to ensure the efficient re-use of Internet standards. The IMS architecture is divided into three different layers .Service/application layer, IMS layer, and transport layer [5] as depicted in Figure 2 [2].

The IMS core architecture consist of Call/Session Control Functions (CSCFs) and a Home Subscriber Server (HSS). The CSCFs are the core elements and play important roles in IMS. It is worth to mention that CSCFs could be running on a single computer or distributed over multiple computers [5]. More of details about CSCF can be found in [2]. The Home Subscriber Server (HSS) provides a central database of subscriber information. This database enables the IMS network entities to handle SIP sessions and performs authentication and authorization of the subscriber and it is an evolution of the Home Location Register (HLR) of Global System for Mobile

Communication (GSM) and Authentication Center (AuC) [2].

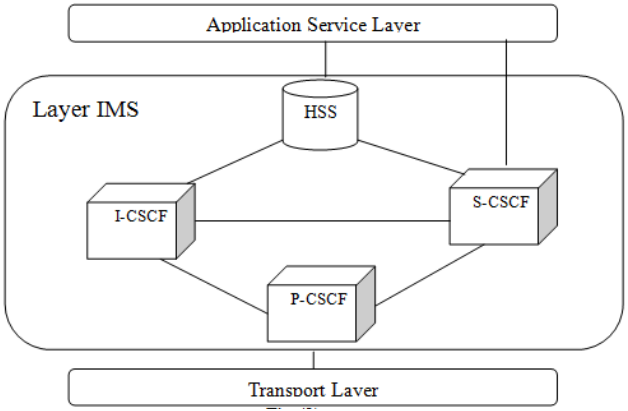

Figure 2 IMS Architecture

1.3 Cloud Computing

There are several definitions of cloud computing [6, 7, 8]. However, the U.S. National Institute of Standards and Technology (NIST) has defined Cloud Computing, NIST SP 800-145 [9] as:" a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". It was actually evolved of several computing paradigms, such as virtualization, grid computing, distributed computing and storage elasticity,[10, 11, 12].Cloud computing enables on demand provisioning of services independent of the location and underlying technology. It has created a variety of business opportunities and consequently reforming the ICT business model [6]. Figure 3 shows vision of a cloud architecture [2].

This cloud essentially has general characteristics, on-demand self-service where consumers can automatically provision computing capabilities based on users requests without requiring human intervention with a cloud service provider. Consumers can easily access the capabilities regardless of the user terminal or platform (e.g. mobile phones, laptops, etc) .These computing capabilities is provided via the cloud provider's pool of physical hosts and virtual machines which dynamically controlled, optimized, allocated and de-allocated according to the customer requests and agreed service level agreements (SLA) at any time without QoS degradation. There are several Cloud service models as described by NIST SP 800-145 [9], for instance cloud computing can support everything as a service (XaaS). It can be categorized generally into three different service models. Software as a Service (SaaS) also called Application as a Service (AaaS).

(AaaS) provides on demands availability of software or an application to consumers over the internet which is hosted on cloud then makes this software accessible through software interface, there is also Platform as a Service (PaaS) provides a development environment for the development of applications and Infrastructure as a Service (IaaS) where cloud service provider delivers computing infrastructure (processing, storage, networks, etc) on demand. The user can select their operating system, storage, and deployed applications; [9], [2]. IaaS can be further divided according to the provided infrastructure for instance if the provided infrastructure is computing processing IaaS is called Communication as a service CaaS and so on.

1.4 Scalability

One of the main objectives of the cloud computing is provisioning of infinite scalability. Generally cloud architecture can scale up or down in either of two different approaches to serve demands: vertically or horizontally. Vertical scaling rely on deploying more powerful computing resources to accommodate the demand. This scale-up approach generally works well, but involves huge capital expenditure, while inhorizontal approach, the scale out approach gradually scales computing resources in small chunks to accommodate the demand. However, horizontal scaling requires continues monitoring of demands. However, horizontal scaling requires continues monitoring of demands then scaling the infrastructure accordingly. Elasticity has to be considered as fundamental characteristics of the cloud computing as it offers optimal utilization of the computing infrastructure's resources that aligns the dynamic scale-up and scale-down of resources with actual demand. [2]

2.0 STATE OF THE ART

Actually there has been a tremendous research work that is being taken place in the area of cloud computing however there are much less on the area of application of cloud in telecommunication or communication as a service, NGN and IMS. In [13] opportunities to integrate grid and cloud computing strategies and standards into NGN are considered.

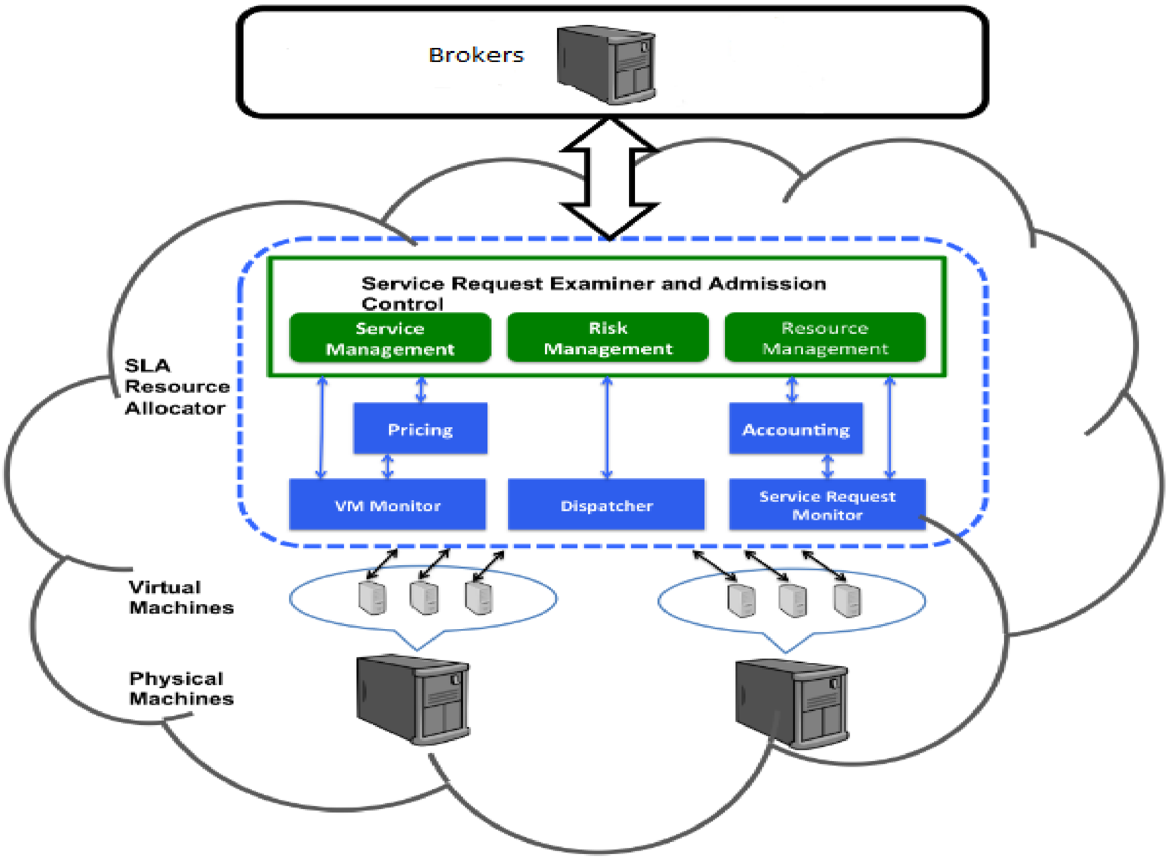

Figure 3 Cloud Architecture

The importance of standardized interfaces and interoperability testing demanded by carrier-grade networks are discussed. Finally, a proposal of how the testing methods developed that can be applied to improve the quality of standards is presented, it highlighted the interoperability issues in Grid and cloud systems although it is slowly changing. ETSI intends to continue standardizing software protocols and interfaces relevant to NGN and adopting grid and cloud computing technology into the global telecommunications network. It is worth to mention that resource optimization in cloud based next generation telecommunication network is considered an other research area and can be expanded in other research papers including power management and VM consolidation .However resource optimization techniques in cloud computing can be adopted for the telecommunication networks. Authors in [14] analyzed interconnection interfaces and interoperability testing demanded by carrier-grade networks are discussed. Finally, a proposal of how the testing methods developed that can be applied to improve the quality of standards is presented, it highlighted the interoperability issues in Grid and cloud systems although it is slowly changing ETSI intends to continue standardizing protocols and interfaces relevant to NGN and adopting grid and cloud computing technology into the global telecommunications network. It is worth to mention that resource optimization in cloud based next generation telecommunication network is considered an other research area and can be expanded in other research papers including power management and VM consolidation .However resource optimization techniques in cloud computing can be adopted for the telecommunication networks. Authors in [14] analyzed interconnection scenarios for combining Cloud-based systems and an Evolved Packet Core (EPC) to offer new value-added applications in a unified architecture. The EPC and IMS are described as possible vehicles for the integration. Caryer, *et al*. [15], proposed a solution based upon combining grid/cloud technology services to deploy Next Generation Network (NGN) functionality In [16], Telecommunication centric cloud ecosystem, cloud services and use cases has been shown and the most interested part is the Network infrastructure of a cloud echo system network model. Jiann-Liang Chen, *et al*. [17], presented a solution for offering high quality multimedia applications by combing the IP Multimedia Subsystem (IMS) architecture with a cloud computing infrastructure. Many researchers think that IMS infrastructure can be deployed on a large scale together with next-generation networks to fulfill the increasing demands for Internet based services.

Unfortunately, according to Makaya *et al*. [18]. The IMS core network components do not scale easily due to its complex nature. They have proposed a self-organizing IMS that enables IMS functional components to adapt dynamically and automatically based available system resources as depicted in Figure 4 [18]. The paper described performance evaluation in terms of number of processing time and control signaling.

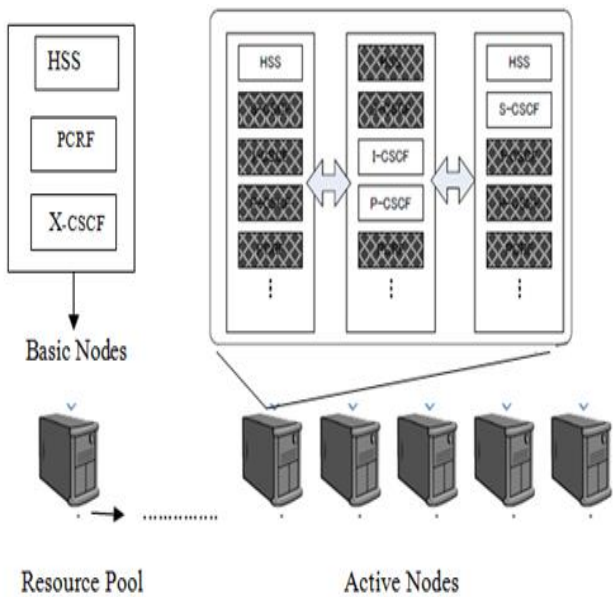

Figure 4 Self organizing (IMS)

In the proposed approach the physical nodes that are capable of running several IMS components are resides in the resource pool. Then According to the load and network conditions, the nodes can adapt the components and run one or multiple instances of them. Based on negotiation with each other it may take over missing components to maintain the IMS automatically in case of trouble. The processing is moved to other nodes and the unnecessary node is removed when the physical resource is not needed any more. Thus, it realize the effective resource usage. In [19], European Telecommunications Standards Institute (ETSI) workshop is organized on standardization of application of cloud in telecommunication. Among the issues highlighted were trust; legal requirements (e.g. privacy, data security, integrity); jurisdiction; portability; interoperability of providers and services); labeling of cloud services; terms, definitions and studying of the implications of cloud computing on the design of telecommunications networks. Table 1 [19] shows some cloud based services with different categorization In [20], the potentials of cloud computing in telecommunication were highlighted from two perspectives, the first one considering the telecommunication provider as a cloud provider and from another perspective considering the provider as

Table 1 Some telecommunication cloud based services as recognized by ITU

	SaaS	PaaS	IaaS	NaaS	CaaS
Desktop as a service			X		
Service delivery plate form as a service	X	X			
Cloud communication center	X				X
VPN				X	
Bandwidth on Demand				X	

Figure 5 [20] shows a model of how a telecommunication service provider can act as a cloud user.

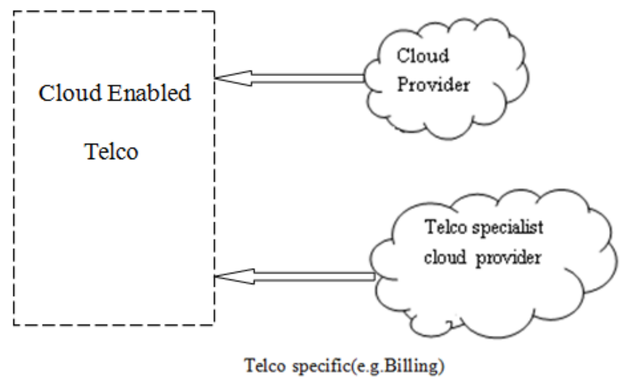

Figure 5 Model of telecommunication service provider as a cloud user

In Carella, *et al*. [21] FOKUS cloud broker have been optimized and evaluated through experimentation in a multi-site cloud testing facility. The result of this work have shown the benefits of network-aware cloud brokering mechanisms, especially for meeting QoS requirements of real-time communication services In I. Albarrán, *et al*. [22] master's thesis the utilization of cloud technology in for telecommunication services has been proposed . In addition to that, a cloud implementation of a specific MSC-S application, has been tested and evaluated. P. Bellavista, *et al*. [23], have proposed a novel cloud brokering system for IMS based services. They implemented a solution that guarantees QoS for cloud based IMS service by dynamically scaling-up/scaling-down server computing resources, and enabling services to migrate across multiple cloud platforms. A key part of the proposed project is to analyze a solution for the deployment of an IMS core network infrastructure in a cloud computing architecture. X. Zhiqun, *et al*. [24], have proposed the virtualization of the IMS core network and radio access network (RAN) as an application of Telco cloud. Tinniam V. Ganesh [25] proposed cloud architecture for an IMS infrastructure. In this proposal the IMS core network components would be deployed on distributed cloud platforms either in public or private clouds. In Muhammad Umair, [2] thesis project, a solution for horizontal scalability of the database underlying the HSS is investigated in order to scale the number of database instances. The main goal is to enhance both HSS availability and performance. The solution is evaluated for the development of IMS core network infrastructure in a cloud computing architecture. Carella *et al*. [26] introduces a set of three software architectures for efficient virtualization of IP Multimedia Subsystem (IMS) in different operator environments responding to the high level requirements of the ETSI NVF. Additionally, a management architecture for simplifying the deployment and runtime orchestration of such a virtual service on top of a cloud infrastructure is presented. Furthermore, one of the IMS software architectures was implemented based on the Fraunhofer FOKUS Open IMS Core, evaluated on top of an OpenStack cloud.

3.0 CONCLUSION AND FUTURE DIRECTIONS

The maturity reached by virtualization technology enabled great hardware utilization and innovation for efficient applications and services delivery, independent of the underlying hardware equipment, especially with the large deployment of off-the-shelf hardware based cloud infrastructures. In order to take advantage of this technology, the existing network functions have to be developed and adapted to the new paradigm. However, traditional telecom services are still implemented on dedicated hardware resulting in high deployment and maintenance costs compared to the other already cloudified services. Despite the reported state of the art where there are a tremendous efforts, researches and industrial trials that are going in. there is still a gap in application in cloud computing and virtualization in NGN specifically in the IMS where high availability design is very crucial, specially for the current robust high demand data environment, in the essence that it can be seen from an ISP perspective in the internal network architecture where a concepts of redundancy, load balancers, traffic engineering, live migration in virtualization, disaster recovery and cluster computing are taking place .As future directions the there are an immense potentials in these area and some areas that are less investigated such as cloud based IMS network, and particularly Call session control functions (CSCF). The CSCFs are not only critical in terms of having sufficient capability to accommodate large number of request concurrently, but also in terms of having high availability and as the number of subscribers are growing exponentially. If any of the CSCF cannot handle a sufficiently large number of simultaneously requests, call block drop and delay in response time would increase. Therefore intelligent Load balancing is one of the techniques that is used to optimize resources in cloud and virtualized environment. Thus an analysis of using different load balancing

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