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CLOUD COMPUTING ENVIRONMENT IN LAN NETWORK

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Abstract Cloud computing is an Internet based resource sharing which trigger broad network access. This cloud computing technology is a new technology which delivers a new model for information and services by means of an existing grid computing technology. Further, this new technology uses Internet infrastructure to communicate between the client and the server side service applications. Apart from this, cloud computing has cloud service provider they offers cloud platform for their customers to create and use web oriented services. The hardware and software resource sharing is possible in cloud with the help of internet and it can be managed and maintained by the third party cloud service provider. The cloud service provider facilitates cloud computing to increase the capacity or add capability, for example without investing in a new infrastructure, training new people or licensing new software. It is packed with a new infrastructure to improve the services like scalability, elasticity, business agility, faster start up time, reduced management cost and availability of resources. This special Internet based shared resource has its own conceptual, technical, economical and user experience characteristics. Nowadays, cloud computing has become one of the most important and popular research areas in the field of computer science. Many open research problems are available in cloud computing and good solutions also been proposed by the researchers by developing new techniques and efficient algorithms. In this paper, a detailed study about cloud computing, its basic concepts, history, virtualization technique, and cloud.

Keywords: Cloud Computing, virtualization, Brokering Services, Research Issues, Security Issues

I Introduction

Cloud computing is a technology it delivers a new model form existing grid technology and based on internet resources sharing and broad network access Cloud computing model is composed of five essential cloud characteristics, namely on demand self-services, Broad network access, Independent resources pooling, Rapid elasticity, and Measured service, which include four deployment models such as private, public, hybrid, and community. Cloud computing has three service models namely PAAS, IAAS, SAAS. Cloud computing has rapid deployment which is used to speed up the time which fastens the workload. It also facilitates low start-up cost which includes the capital investment; costs based on usage or subscription, multi-tenant sharing services and resources, and accelerated deployment. This modern technology has massive scalability which has the ability to scale the bandwidth and storage space of tens and thousands of systems and the elasticity users can increases a multi-tenancy. Cloud computing is based on a business model in which resources are shared at the network, host, and application services are discussed. In addition to this, research issues in cloud computing also discussed.

II. BACKGROUND OF CLOUD COMPUTING

This section introduces the main fundamentals and concepts that may be needed to follow the paper. We briefly present the historical evolution of CC; then we discuss the foundational technologies of CC, and compare the different CC service models.

2.1 History and Emergence of Cloud Computing

This section presents the most relevant aspects related to the history of CC. We start, however, with the origin of "cloud"; this word means an abstraction of the underlying infrastructure (computers, networks, data storage) that enables the normal operation of any CC system. It is also why network infrastructures have for many years been represented by an iconized "cloud", hiding its complex details from non-specialized individuals. The additional words presented together with "cloud" identify the scope of that "cloud", and it could be for example any of the following: computing, networking, mobile computing, and sensor networks. In addition, CC glossaries are available in (CCGa 2014) (CCGb 2014). Furthermore, some CC taxonomies are in (Rimal, Choi and Lumb 2009) (Beloglazov, et al. 2011).

Table II briefly shows the historical evolution of CC since the 1960s until 2011.

More recently, in 2013, an international congress (Services 2013) gave special attention to Big Data Research and its major impact on social development (Obama 2012). Big Data is a recent trend (Ward and Barker 2013) (Diebold 2012) (Press 2013) which aims to extract pertinent knowledge from large-scale, complex, 4 J. Moura, and D. Hutchison and unstructured data. This work is being carried out by numerous organizations including NSF, DoD, and DARPA. Some DARPA Big Data projects related to CC are described in (DARPA_a 2013) (DARPA_b 2013). Big Data implementation strongly depends on the existence of Internet cloud solutions to support big data storage, to scale up the distributed/parallel processing power, to enhance collaborative work, and to support the efficient, secure, and private access of mobile terminals to heterogeneous data and services (Moura and Serrão 2015).

Table II. Cloud Computing Historical Evolution

Table II. Cloud Computing Historical Evolution from 1960s until 2011 Organization / Project	CC Related Main Achievement	Year(s)
IBM	Mainframe time-sharing technology	1960's
MicronPC (changed to Web.com)	Initial provider of websites and web services to small businesses and consumers	1995
Salesforce	Enterprise-level applications to which end users could have access via their Internet connections	1999
Amazon	Mechanical Turk was offered as an online marketplace for work	2002
Amazon	The first widely accessible CC infrastructure service (Elastic Compute Cloud - EC2).	2006
Academic Cloud Computing Initiative (ACCI) project	The ultimate goal of this project was to prepare students to explore the new potential cloud systems could offer at that time	2007
Google	Google Docs avoided the need for end-users to have locally licensed and always updated applications in their devices because the applications were stored in a remote and centralized location; collaborative working was in this way much easier to deploy	2007
Eucalyptus, OpenNebula	These were launched as the first open-source computing toolkits for managing clouds	2008
Microsoft	Windows Azure was launched a cloud solution	2010
IBM	The Smarter Computing framework was announced including CC as a relevant tool	2011

Clearly, CC evolution is currently related to the increasing popularity of Big Data. In fact, CC provides the necessary computation, storage, applications, and networking, which support Big Data applications. These applications empowered by CC solutions can extract very useful information to guide better decisions in many usage areas like business, finance, politics, education, military, industry, transportation, research, and even healthcare (Griebel, et al. 2015) .

There are also important research areas for Future Networks with a strong relation to CC. These include Internet of Services, Grids, Service Oriented Architectures, Internet of Things (IoT), and Network Functions Virtualization (NFV). These two last areas (i.e. IoT and NFV) are discussed at the end of the paper in terms of network challenges that should be addressed to satisfy their major requirements when they are implemented within the cloud.

In the next sub-sections, the concepts and technologies of CC are discussed.

2.2 Definition of Cloud Computing

There is an analogy between electricity and CC. Electricity is, of course, a utility where we expect a certain set of qualities (e.g. always-available, “five nines” reliability) and we believe that CC should aspire to be a utility too (Voorsluys, Broberg and Buyya 2011).

CC refers to computing services that are provided within a cloud infrastructure and accessed on demand by customers, so that the customers do not have to be concerned with the details of service provisioning.

Now, we present some definitions of CC. (Buyya, et al. 2009) have characterized it as follows: “Cloud is a parallel and distributed computing system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLA) established through negotiation between the service provider and consumers.” The National Institute of Standards and Technology (NIST) (Mell and Grance 2011) has defined CC as “… a model for enabling 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.” Further definitions about CC are available in (Voorsluys, Broberg and Buyya 2011).

In recent years, the rise of CC is due to several foundational technologies that are discussed in the next sub-section.

2.3 Foundations of Cloud Computing

CC resulted from the convergence of several technologies belonging to four distinct fields: hardware (e.g. virtualization), distributed computing (e.g. grid computing), the Internet (notably service-oriented applications), and network management (Voorsluys, Broberg and Buyya 2011).

Cloud services are normally situated in data centers each deploying thousands of computers. These systems need to scale up to very high rates of service demand with an acceptable processing time, and also with low costs in terms of energy and hardware. To achieve these goals, a conceptual cloud model such as the one shown in Figure 1 could be adopted.

III Methodology

Challenges in IaaS Among various challenges that should be addressed in an IaaS deployment, in this work we focus on virtual networking and cloud extension and cloud federation issues and in the sequel we provide innovative opportunities that could be utilized to address these issues. Existing networking protocols and architectures such as Spanning Tree protocol and Multi-Chassis Link Aggregation (MC-LAG) can limit the scale, latency, throughput and VM migration of enterprise cloud networks. Therefore open standards and proprietary protocols are proposed to address cloud computing networking issues. While existing layer 3 "fat tree" networks provide a proven approach to address the requirements for a highly virtualized cloud data center, there are several industry standards that enhance features of a flattened layer 2 network, using Transparent Interconnection of Lots of Links (TRILL), Shortest Path Bridging (SPB) or have the potential to enhance future systems based on SDN concepts and OpenFlow. The key motivation behind TRILL and SPB and SDN-based approach is the relatively flat nature of the data-center topology and the requirement to forward packets across the shortest path between the endpoints (servers) to reduce latency, rather than a root bridge or priority mechanism normally used in the Spanning Tree Protocol (STP). The IEEE 802.1Qaz, known as Enhanced Transmission Selection (ETS), in line with other efforts, allows low-priority traffic to burst and use the unused bandwidth from the higher-priority traffic queues, thus providing greater flexibility [4]. Vendor proprietary protocols are also developed by major networking equipment manufacturers to address the same issues.

For instance Juniper Networks produces switches, using a proprietary multipath L2/L3 encapsulation protocol called QFabric, which allows multiple distributed physical devices in the network to share a common control plane and a separate common management plane. Virtual Cluster Switching (VCS) is a multipath layer 2 encapsulation protocol by Brocade, based on TRILL and Fabric Shortest Path First (FSPF) path selection protocol and a proprietary method to discover neighboring switches. Cisco's FabricPath, is a multipath layer 2 encapsulation based on TRILL, which does not include TRILL's next-hop header, and has a different MAC learning technique. They all address the same issues with different features for scalability, latency, oversubscription, and management. However, none of these solutions have reached the same level of maturity as STP and MAC-LAG [4].

Layer 2 (switching) and Layer 3 (routing) are two possible options for cloud infrastructure networking. Layer 2 is the simpler option, where the Ethernet MAC address and Virtual LAN (VLAN) information are used for forwarding. The drawback of switching (L2) is scalability. L2 networking flattens the network topology, which is not ideal when there is large number of nodes. Routing (L3) option and subnets provide segmentation for the appropriate functions at the cost of lower forwarding performance and network complexity.

Existing cloud networking architectures follow the "one size fits all" paradigm in meeting the diverse requirements of a cloud. The network topology, forwarding protocols, and security policies are all designed looking at the sum of all requirements preventing the optimal usage and proper management of the network. Some of the challenges in the existing cloud networks are:

- **Application performance:** Cloud tenants should be able to specify bandwidth requirements for applications hosted in the cloud, ensuring similar performance to on premise deployments. Many tiered applications require some guaranteed bandwidth between server instances to satisfy user transactions within an acceptable time frame and meet predefined SLAs. Insufficient bandwidth between these servers will impose significant latency on user interactions. Therefore without explicit control, variations in cloud workloads and oversubscription can cause delay and drift of response time beyond acceptable limits, leading to SLA violations for the hosted applications.
- **Flexible deployment of appliances:** Enterprises deploy a wide variety of security appliances in their data centers, such as Deep Packet Inspection (DPI) or Intrusion

Detection Systems (IDS), and firewalls to protect their applications from attacks. These are often employed alongside other appliances that perform load balancing, caching and application acceleration. When deployed in the cloud, an enterprise application should continue to be able to flexibly exploit the functionality of these appliances.

- **Policy enforcement complexities:** Traffic isolation and access control to the end-users are among the multiple forwarding policies that should be enforced. These policies directly impact the configuration of each router and switch. Changing requirements, different protocols (e.g., OSPF, LAG, VRRP), different flavors of L2 spanning tree protocols, along with vendor specific protocols, make it extremely challenging to build, operate and inter-connect a cloud network at scale.
- **Topology dependent complexity**: The network topology of data centers is usually tuned to match a pre-defined traffic requirement. For instance, a network topology, which is optimized for east-west traffic (i.e., traffic among servers in a data center), is not the same as the topology for north-south (traffic to/from the Internet). The topology design also depends on how the L2 and/or L3 is utilizing the effective network capacity. For instance adding a simple link and switch in the presence of a spanning tree based L2 forwarding protocol, may not provide additional capacity. Furthermore, evolving the topology based on traffic pattern changes also requires complex configuration of L2 and L3 forwarding rules.

- **Application rewriting:** Applications should run “out of the box” as much as possible, in particular for IP addresses and for network-dependent failover mechanisms. Applications may need to be rewritten or reconfigured before deployment in the cloud to address several network related limitations. Two key issues are: 1) lack of a broadcast domain abstraction in the cloud network and 2) cloud-assigned IP addresses for virtual servers.

- **Location dependency** Network appliances and servers (e.g., hypervisors) are typically tied to a statically configured physical network, which implicitly creates a location dependency constraint. For instance the IP address of a sever is typically determined based on the VLAN or subnet it belongs to. VLAN and subnets are based on physical switch port configuration. Therefore, a VM cannotbe easily and smoothly migrated across the network. Constrained VM migration decreases the level of resource utilization and flexibility. Besides, physical mapping of VLAN or subnet space to the physical ports of a switch often leads to a fragmented IP address pool.

- **Multi-layer network complexity:** · A typical three layer data center network includes TOR layer connecting the servers in a rack, aggregation layer and core layer, which provides connectivity to/from the Internet edge. This multi-layer architecture imposes significant complexities in defining boundaries of L2 domains, L3 forwarding networks and policies, and layer-specific multi-vendor networking equipment.

IV Result and Analysis

SDN-based Cloud Computing Networking

SDN [7] is an emerging network architecture where "network control functionality" is decoupled from "forwarding functionality" and is directly programmable [6], [7]. This migration of control, formerly tightly integrated in individual networking equipment, into accessible computing devices (logically centralized) enables the underlying infrastructure to be "abstracted" for applications and network services. Therefore applications can treat the network as a logical or virtual entity. As a result, enterprises and carriers gain unprecedented programmability, automation, and network control, enabling them to build innovative, highly scalable, flexible networks that readily adapt to changing business needs. A logical view of the SDN architecture is depicted in Figure 3. OpenFlow is the first standard interface designed specifically for SDN, providing high-performance, granular traffic control across multiple vendors' network devices. Network intelligence is logically centralized in SDN control software (e.g. OpenFlow controllers), which maintain a global view of the network. As a result the network, in its ultimate abstracted view, appears as a single logical switch. Adapting SDN architecture, greatly simplifies the design and operation of networks since it removes the need to know and understand the operation details of hundreds of protocols/standards. Enterprises and carriers gain vendor-independent control over the entire network from a single logical point.

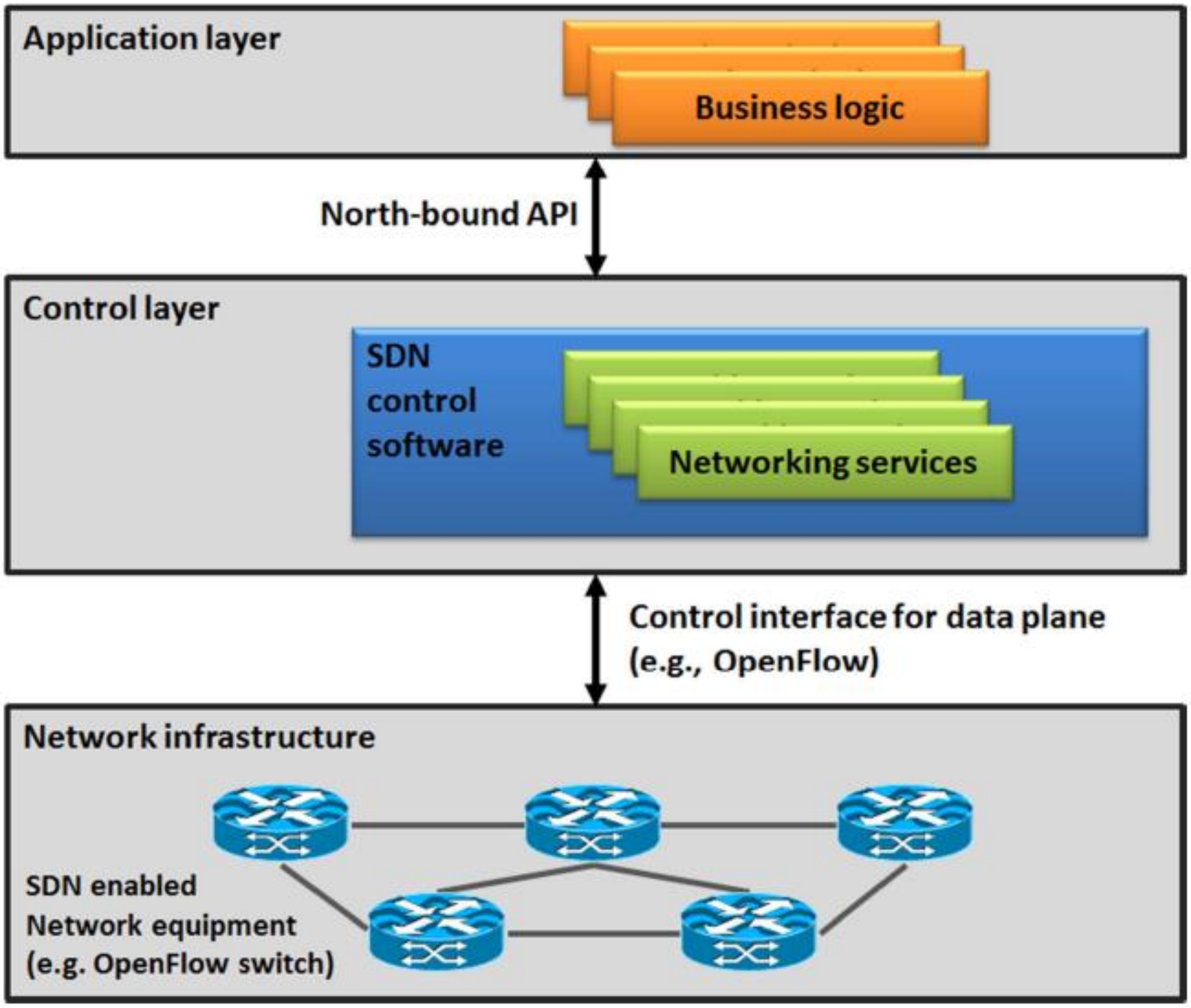

Figure1 Logical view of SDN architecture

In addition to the network abstraction, SDN architecture will provide and support a set of APIs that simplifies the implementation of common network services (e.g., slicing, virtualization, routing, multicast, security, access control, bandwidth management, traffic engineering, QoS, processor and/or storage optimization, energy consumption, and various form of policy management). SDN's promise is to enable the following key features:

V Conclusions

In this article the infrastructure as a service (IaaS) architecture and key challenges with a focus on virtual networks and cloud federation were presented. IaaS has provided a flexible model, in which customers are billed according to their compute usage, storage consumption, and the duration of usage. Some of the challenges in the existing Cloud Networks are: guaranteed performance of applications when applications are moved from on-premises to the cloud facility, flexible deployment of appliances (e.g., deep packet inspection, intrusion detection systems, or firewalls), and associated complexities to the policy enforcement and topology dependence. A typical three layer data center network includes TOR layer connecting the servers in a rack, aggregation layer and core layer, which provides connectivity to/from the Internet edge. This multi-layer architecture imposes significant complexities in defining boundaries of L2 domains, L3 forwarding networks and policies, and layer-specific multi-vendor networking equipment. Applications should run “out of the box” as much as possible, in particular for IP addresses and for network-dependent failover mechanisms. Network appliances and servers (e.g., hypervisors) are typically tied to a statically configured physical network, which implicitly creates a location dependency constraint. SDN architecture in addition to decoupling the data forwarding and control planes will provide and support a set of APIs that simplifies the implementation of common network services. VLAN, VM-aware networking, vCDNI, VXLAN and Nicira NVP are technologies to provide virtual networks in cloud infrastructures. Nicira NVP, which utilizes MAC in IP encapsulation and external control plane provides the efficient solution for virtual network implementation. OpenFlow core and edge nodes with a proper OpenFlow controller can be considered as a novel cloud federation mechanism. SDN-based federation will facilitate multi-vendor networks between enterprise and service provider data centers, helping enterprise customers to choose best-in-class vendors Network fabric, which is a proposal for network edge version of Open Flow is one of the recent proposals towards extension of SDN to increase the simplicity and flexibility of future network designs. What we should make clear, is that SDN does not, by itself, solve all the issues of cloud computing networking. The performance of SDN deployments, the scalability issue, the proper specification of northbound interface in SDN and co-existence and/or integration of SDN and network function virtualization, and proper extension to the OpenFlow to make it a viable approach in WAN-based application (e.g. EU FP7 SPARC project) are among the topics that need further research and investigations.

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