Analysing key aspects of Network virtualisation in cloud computing: NaaS

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Abstract

The pivotal role specifies by networking in Cloud computing demands a comprehensive approach that enables control as well as management, which further optimizes networks and a computing methods provided for resources needed with in Cloud domain. The vital design success is to be put into use in combination with NaaS which is enabled networks, that should be managed systematically , in a method that needs only lessen human interaction as well as across administrative network spectrum. We introduce a classification of the Network as a Service in our paper, which could be merged with other cloud services. In this paper we present a thorough survey on the current developments from a view point of the network and Cloud emergence in NaaS. Particularly , firstly we put forth the NaaS architecture and analyse current research enhancement on applying various techniques to be supported for virtualization in network field in cloud computing. We have taken into consideration of a virtual network operator which is a third party vendor, who will provide NaaS service for cloud consumers using cloud services. The vendors leases bandwidth from internet Autonomous Systems to set up connections between numerous user nodes and data centres. Then we present an architecture of network-as-a-service focusing on some key technologies for realizing NaaS. We also discuss the use cases as well as standards captured by the network Cloud emergence to these technologies and certain benefits of adoptions onto these network areas, with a motive to inspire the researchers interest in this proceeding multidisciplinary field.

Keywords: NaaS, Cloud Computing, SD-WAN, NDL, Open stack, Openflow and NaaS API

I. Introduction

The conspicuous advancement in the domain of information technology which lead to emergence of a promising technology known as Cloud Computing. Cloud computing is a prototype for swift provisioning all types of computer resources globally, well suited with the requirement of users based on their demand allowing least interaction with service vendors. This model contains five necessary elements, three serving models, and four models suitable for deploying cloud requirements.[1] Using this functional design resourced are shared among all users , hence become a multi-tenant model. Cloud consumer can access virtualised pool of resources (including storage, network, virtual machines, CPUs, and so on) based on their requirement . It follows a distributed pattern driven by economies of scale, where pool of scalable resources are provisioned to customers on demand over the internet.[2] Cloud computing applications are distributed globally , therefore require efficient network access to perform various operations. In traditional IT models clients can select the type or quantity

of storage and computational resources required for their applications, nevertheless they are incapable of managing and accessing the network infrastructure.[6]
Taking into consideration of all these factors, providers recently proposed a cloud based network paradigm named as "Network as a service". In this paradigm, on demand cloud network services are provisioned by providers by imposing charges customers in accord to pay-per-use model. It enhances the connection of various network components using virtualised layer (VPC,VLAN,VPN etc). This model deals with the level of not only accessibility and control but also reliability and security assurance to consumers. As cloud is a multi-tenant model which offers the ability to migrate certain services from one provider to another provider, taking into consideration of network bandwidth connectivity and latency issues. Therefore , providers can provision NaaS to their consumers where they can customise applications based on their needs, for instance workload distribution by load balancer or custom multicast services. [5]Which lead to the design of efficient network service, like stream processing, aggregation of data, data caching, and redundancy elimination protocols.

By using Network-as-a-Service service provider allows service consumers to ingress network easily and securely. Here, network providers offer an assurance of negligible packet loss and consistently low latency while using NaaS. Hence, it will significantly enhances the application performance. NaaS allows service consumers to ingress network easily and securely. It is feasible for consumers to deploy custom routing protocols.[5] Network provider will provision virtual network infrastructure to their clients. It comprises of various network oriented services such as providing virtual private networks, on demand bandwidth, virtual private cloud on demand, fastest network connection guarantee, global access, and many more. Service provided by telecommunication manufacturers known to be mobile network virtualization , offers guaranteed uptime to their clients.

II. Related survey

In this forthcoming section, we review certain perspectives which are associated to Network service component specifications in the Cloud Networking environment.

Q. Duan et al.[6] surveyed on the current developments and latest achievements pertaining to the service-oriented network virtualization with the motive of assisting Cloud computing, specifically from a network point of view and Cloud emergence with NaaS. They reviewed certain SOA principles as well as some current research enhancement on applied SOA to assist network virtualization in computing. They faced some issues related to composition and discovery of networking technologies and proposed some future research.

P. Costa et al.[7] proposed framework named *Network- as-a-Service* (NaaS), that consolidates the latest cloud computing production with direct access to the network infrastructure. Using this technology tenants can deploy custom routing as well as multi-cast protocols.They discussed various applications and motivated the functionalities required by NaaS, further sketched a possible implementation as well as programming model that can be reinforced by latest technology. At last they concluded by providing a small-fraction of applications with additional fine-grained control over network computing resources allows a well organised usage of the network, which results in enhanced performance for each and every tenant.

I. Ayadi et al. [5] suggested QoS control and management on cloud network services which may particularly result in the application outcomes. Hence, predominantly the main issues were handled by the NaaS service vendors . Firstly, the QoS offered by each of the cloud networking service and secondly, in order to provide application flow requirement, advanced services differentiation. They had also presented a spectrum of QoS-assured cloud networking services and proposed a domain of service taxonomy to be dealt with the flow of cloud computing application requirements , which results in the suggested approaches to administer per-connection constitution of a virtual networking within cloud , where QoS is pre-requisites in the application flows.

F. Baroncelli et al [7] introduced a narrative categorisation of the NaaS so that it could be arranged well with diversity of cloud services. They also proposed a middle ware layer knows as network virtualization platform (NVP) which should be able to offer NaaS to cloud computing and this could be done by exploring the features and validation provisioned by certain control plane (CP) with enabled networks. Finally, they presented a full-fledged paradigm from the software implementation as well as network signalling viewpoint of two predominant use-cases in which NaaS is elaborated as independent facility for the establishment of connections for service deployment or is emerged with other cloud deployments for a storage service offering.

D. Kakadia et al.[8] proposed a NaaS, which forms the premises of merging public and private clouds. Then, they identified various challenges in acquiring of hybrid cloud. They discussed a various platforms as well as its implementation for a hybrid clouds for offering NaaS along with other compute services, by utilising the functionality offered by software defined networks. They reckoned that beside fueling hybrid cloud acquisition, NaaS provided by their platform can be beneficial in various other circumstances also. Therefore, the platform offers a captivating mechanism toward providing experimentation, providing virtualization, and the deployment of latest protocols and network architectures within least changes required.

D. Dudkowski et al. [9] presented an elaborated INM prototype that they had implemented to the demonstration of INM's abilities, which were based on their priorly introduced INM architecture. By establishing a narrative network scenario, they discussed a variety of real-time algorithm to signify how INM can be enabled with systematic management of NaaS-enabled networks. Finally they concluded by handling virtual network components above physical component, INM would be abled to attain scalable as well as distributed management for both inside and beyond different administrative sections.

R.Jain et al.[10] described a network virtualization as the fundamental feature for the current and upcoming advancement of cloud computing. They narrated certain reasons for a virtualization and then they exploited some of the networking technologies that have been evolved currently. They particularly focused on the software defined networking, by explaining it as the key element for network programmability, by illustrating SDN's applicability with their research on OpenADN (Open Application Delivery Network) which is an application delivery and provisioning in a multi-cloud environment. As proposed by authors , OpenADN is based on the standardised data plane and it diversified control plane design paradigm proposed by SDN. Hence, using that OpenADN-aware data plane entities, an application delivery services to ASPs were offered by ISPs.

Tao Feng et al.[11]proposed a basic technique of NaaS by emerging the service offering paradigm offered by cloud computing with the ease of accessing the network protocol. They depicted the relative conception as well as stakeholders of networking as a service. additionally , network architecture was designed to be presented the provision and then delivery as well as consumption of networking as a service , they also focused on the discussion of the prime attribures of cloud-based network. They finally went on to propose a paradigm of cloud-based network which was designed by extending OpenFlow architecture. Which is based upon the cloud-based network, they had build a spectrum by extending the OpenFlow architecture with virtualization technology which is to be verified as per the requirement or on-demand offerings of network capacity.

III. **Network-as-a-service (NaaS) Architecture**

This is a prototype that exposes networking resources as well as their working as services which could be controlled with computational services in a Cloud domain. From a service deployment point of view , the services provisioned to end users (i.e service consumer) are necessary composite network-Cloud services that encompasses both computing services offered by Cloud infrastructure as well as network services provided by a network infrastructure.

Soliciting the Service Oriented Architecture in networking grants a virtualization of network resources based on SOA composite network-cloud services .

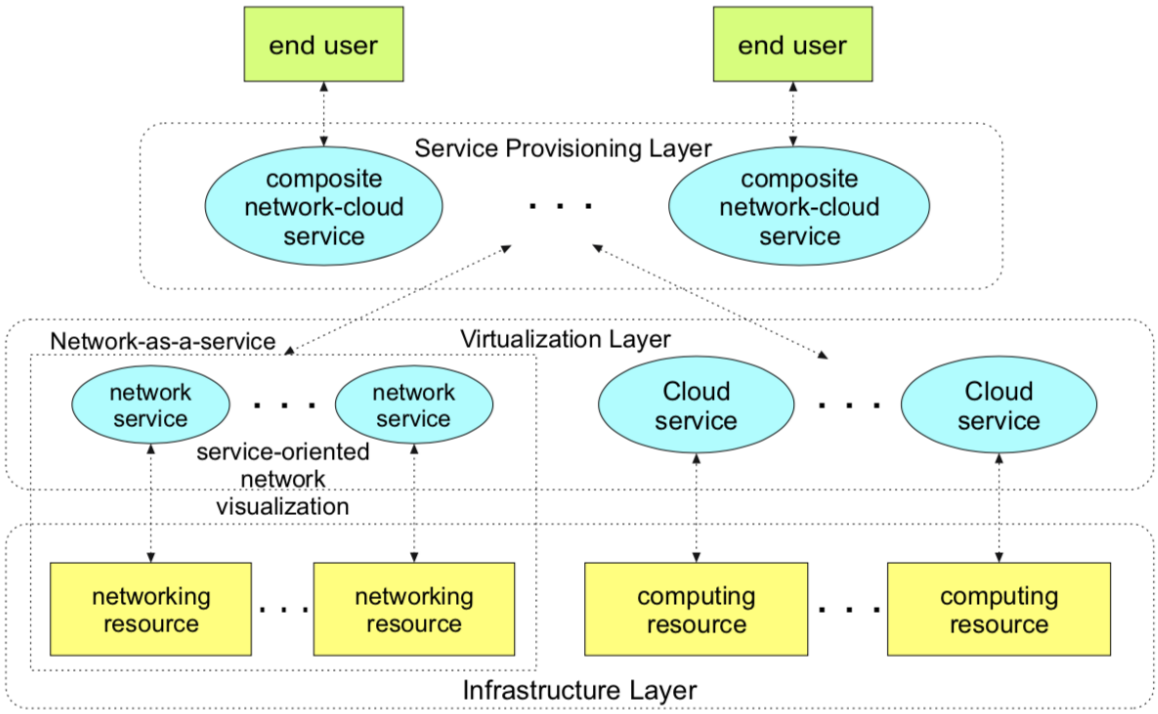

Figure 1. NaaS Architecture

Figure 1 predicts , the service provisioning frame of reference, services received or provided to end users are particularly composite cloud network service that composed of network services provided by the third party network provider and computing services provided by cloud service provider. Figure.1 shows a layered structure for sanctioning the network and computing resources via virtualised layer to the service requester. In this architecture , SOA (Service Oriented Architecture) principle is followed for delivering the network and computing infrastructure with virtualised layer, therefore, it provides a uniformity for coordinating computing and networking systems.

Service-oriented virtualization has successfully comprehended a vision having networking as well as computing resources together as an assemblage of virtualized, a dynamically provisioned resources, which further paves way for coordinated management, control, as well as optimization of the resources over the networking as well as computing zones. In convergence paradigm, NaaS empowers Cloud service requirements with networking potential by provisioning the essential network services. Arrangement of network as well as the computing services enlarges the domain of Cloud services which could be provided to the users.

IV. NaaS use cases

(a) software-defined wide-area network

Migration to cloud network, Network service consumer can easily migrate their on-premises network infrastructure to the cloud by following simple NaaS facility. Initially migration process starts with testing the deployment . Testing process follows the validation of current network infrastructure and then test NaaS infrastructure from provider's datacenter to their current branch. After the testing phase NaaS provider will provide cloud gateway to the requester either through any protocol or software. For instance , SD-WAN (software-defined wide-area network), which is a certain approach of SDN(software defined network) technology solicit the WAN uplinks like MPLS , broadband internet, 3G, 4G connections. By using this SD-WAN technology enterprises can move 50,80 to 100 sites within a night. Hence , they offer agile management through

portal. Third party provider provides APIs (Application programming interfaces) to integrate the maintenance and automotive interface .

(b) Network Description Language (NDL)

Network Description Language (NDL) has proved to be a successful tool to lessen the complexity as networks are supposed to grow in the future. NDL empowers humans as well as machines to have a better understanding on contemporary world's evolved networks to get away with the hassle of dealing with tedious tasks being executed by humans[10]. Certainly, creation of a clear view of any network has been facilitated by the use of Resource Description Framework (RDF). Moreover , it has helped the researchers to establish an ontology for complex networks.

(c) Openstack Network-as-a-service (NaaS)

The key fundamentals of Openstack in the field of Network-as-a-service (NaaS) is to offer a client-facing service for creation as well as managing the networks deliberated as " assembly of virtual ports with shared connectivity"[12]. The excessive level is the provision of connection , isolation as well uniformness . Giving connection by provider means for a given entity (for instance Virtual Machine, Firewalls) to join with another entity. It suites the creation of a comprehensible definition of Compute Network as well as Storage interaction for exchanging data, a novel set of Compute to virtual-Switch (v Switch) to NIC(Network Interface Card) semantics and usage of appropriate addressing (OSI's Layer 2 and Layer 3) and other logic includes provisions for QoS(Quality of Service) as well as Security. Furthermore, providing a client (tenant or a project) which is a stand-alone network that is not shared and accessible by non authorised users or client of the shared physical network is known to be an Isolation. It can be done by Layer 2(data link layer) and/or Layer 3(network layer) logics or physical isolation. Moreover, Uniformity is the strategy of plugins to nodes and any another network services or capabilities such that in a predefined domain of the network (a "NaaS Zone"), all services are provisioned in such a way that permit the workload distribution to be performed globally with that specified network.

V. NaaS standards

(a) OpenFlow

NaaS sometimes comprises the action of providing a virtual network service by the cloud network owners to a third party , who will further distribute the connection to consumers. Often this comprise of network virtualization with the consumption of a protocol such as OpenFlow. **OpenFlow** is a communications protocol that provides an approach to progressive plane of a network switch or a router connected in the network. OpenFlow provision the network controllers to determine the route of network packets across a connected nodes of switches. The controllers are unambiguous from the switches[12] . Thus, the detachment of the control from the progressive allows for further enlightened traffic management than is feasible using access control lists (ACLs) as well as the routing protocols. Moreover, the OpenFlow authorises switches from different providers , particularly specified with their admit proprietary interfaces as well as scripting languages which is to be managed and accessed remotely from any where using a single, open protocol. This protocol's inventors contemplate OpenFlow an organiser of software-defined networking (SDN). The Network as a Service includes: scalable as well as user-friendly, various multicast protocols, with **security** firewall, enabling intrusion detection with prevention, providing a Wide Area Network (WAN), offering a Virtual Private Network (VPN), accessing bandwidth on demand, offering a custom routing content monitoring and filtering.

(b) NaaS APIs (Application programming Interfaces)

The Switching Network NAAS API offers programmatic authorisations to a security as well as authentication procedure for Environmental Information Exchange Network consumers. NAAS API is authorised via SOAP calls enabled with the XML data format. Figure 2, shows a NaaS API extension used a IaaS service offering which is provided by the vendor under the unified cloud controller provisioning. A network established with the NaaS API could be considered as a virtual network switch and the associated network devices associated to it, which possibly spans over various compute nodes in the cloud. Moreover, NaaS APIs should be separated by the real implementation of the necessary service, which are to be offered by a plugin implementing the basic Naas API. Therefore, this suggests that NaaS does not endorse any particular model for the creation of networks (e.g.: VLANs, IP tunnels). However, NaaS API may establish some essential components that a plugin should support. Therefore, the NaaS service could be considered as a container for higher level services, for instance DHCP (Dynamic host configuration protocol) and NAT (Network address translation)[11].

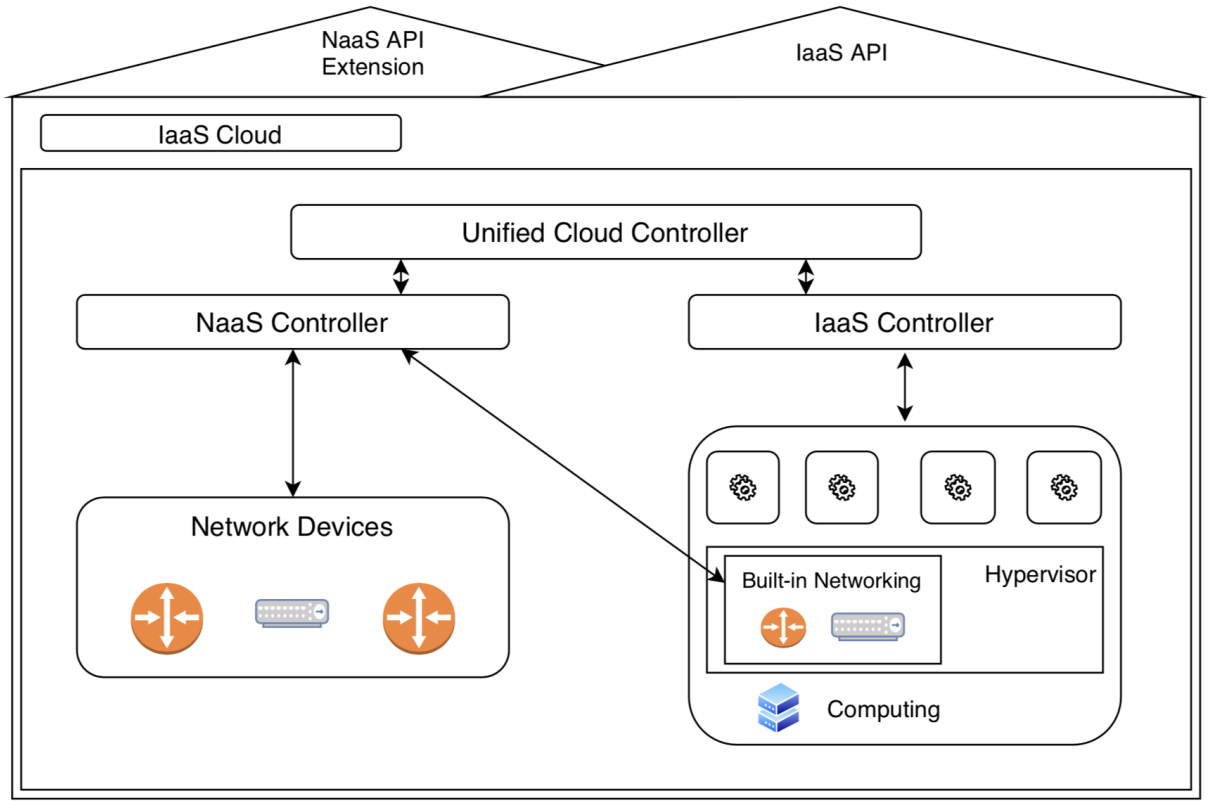

Figure2. NaaS API Interface

VI. Benefits of using Naas in Cloud Computing

By using NaaS provided by cloud providers leads to the global connectivity, with global servers or their branch offices offering ultra secure connectivity. Moreover, network management is ultra simple , [15]as it avoid the hassles linked with legacy network technologies such as upgradation of system, maintenance and deployment and consumer can focus on developing the business , therefore eliminates the maintenance overload[16]. Furthermore, the Visibility is easy and it provides transparent view of network and application for end-to-end service provider and consumer. Figure 3, shows many benefits listed in NaaS .

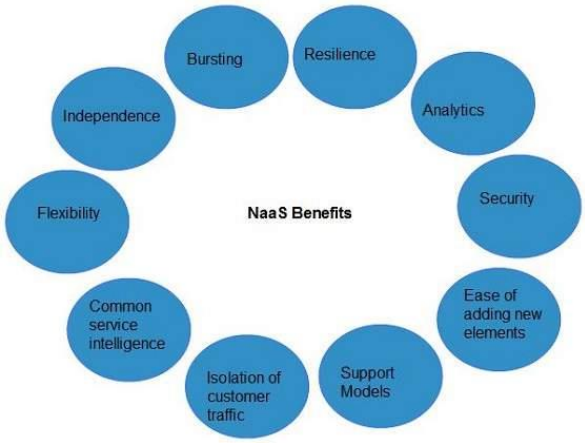

Figure 3, Benefits of using NaaS

VII. Conclusion

Network virtualisation is embraced in various fields such as telecommunications as well as the Internet as a prime fundamental for the upcoming generation networking. The virtualisation, is capable of bridging the gap between the communications and computing domains, and at the same time it validates a convergence of networking and Cloud computing. This paper has put forth various use cases and standards associated with information technologies in the field of virtualised networks. Furthermore, we have discussed certain benefits by adopting this technique .NaaS, specifically focusing on various network service description language , discovery, and the composition. It has also been discussed although NaaS technology is a boon for IT , it faces certain challenges as well. In this paper we reckon that network connectivity is a major contributor for overall performance of applications in the cloud. The ability to provision network services from cloud service provider on demand can aid in tackling various technical as well as business challenges .

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