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Service-Oriented Network Virtualization toward Convergence of Networking and Cloud Computing

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Abstract: *A holistic approach that makes it possible to control, manage, and optimize both computing resources and networking in a Cloud environment is required because of the crucial role that networking plays in Cloud computing. This results in a convergence of networking and Cloud computing. As a crucial feature for the next generation of networking, network virtualization is being implemented in the Internet and telecommunications sectors. It is anticipated that virtualization will bridge the gap between these two fields as a potential enabler of profound changes in the communications and computing domains. When applied to network virtualization, Service-Oriented Architecture (SOA) creates a Network-as-a-Service (NaaS) paradigm that may significantly facilitate the convergence of networking and Cloud computing. The use of SOA in network virtualization has recently received a lot of attention from both academia and industry. Although numerous pertinent research papers have been published, they are currently dispersed across a variety of subject areas in the literature, such as cloud computing, telecommunications, computer networking, and Web services. Specifically, we first introduce the SOA principle and review recent research progress on applying SOA to support network virtualization in both telecommunications and the Internet. In this article, we present a comprehensive survey of the most recent developments in service-oriented network virtualization for supporting Cloud computing, particularly from the perspective of network and Cloud convergence through NaaS. Next, we discuss the most recent advancements in network service description, discovery, and composition, as well as a framework for network-to-cloud convergence based on service-oriented network virtualization. We also talk about the problems these technologies face because of network-cloud convergence and the research opportunities in these areas. Our goal is to get researchers interested in this new interdisciplinary field.*

Keywords: Network virtualization, the service-oriented architecture, cloud computing, network-as-a-Service (NaaS)

I. INTRODUCTION

ONE of the most significant recent advances in the field of information technology is Cloud computing. Cloud computing is a large scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically scalable computing functions and ser- vices are delivered on demand to external customers over the Internet [1]. A technical foundation of Cloud computing lies in the virtualization of various computing resources, which is essentially an abstraction of logical functions from underlying physical resources.

Cloud computing relies heavily on network connectivity. In most cases, cloud services refer to the remote transfer of computing resources, typically via the Internet. This is especially true in public Cloud environments where customers use a third-party Cloud provider for their services. From a service provisioning perspective, Cloud services include both Internet-based communications and Cloud infrastructure-provided computing functions. Networking is also a crucial component for providing data communications between dispersed data centers and Cloud data centers. Recent research on the performance of Cloud computing has shown that data communications become a bottleneck that prevents Clouds from supporting high-performance applications, and that networking performance has a significant impact on the quality of Cloud services [2] [3].As a result, for high-performance Cloud computing, networks with Quality of Service (QoS) capabilities become an essential component.

For example, a high performance application utilizes the Cloud infrastructure for storing and processing a large set of data with a requirement on the maximum service response delay (the time period that the application has to wait for receiving results back from the Cloud after it starts transmitting data to the Cloud). This application may use the storage capacity of Amazon S3 (Simple Storage Service) and the computing capability provided by Amazon EC2 (Elastic Compute Cloud). In order to make the Cloud services available to the application, the underlying network infrastructure must also provide network services for transmitting data from the application to the S3 virtual disk, supporting data communications between the virtual disk and the EC2 virtual machine (Amazon EC2 and S3 servers may be located at different geographical locations that are connected via the Internet), and delivering processing results back to the application. Therefore, the service offered to the Cloud user (this application) is essentially a composition of both Cloud and network services. In order to meet the service delay requirement of the application, sufficient amount of networking resources (e.g. transmission bandwidth and packet forwarding capacity) must be provided in addition to the Cloud infrastructure's computing and storage resources for processing and storing data in order to guarantee network delay performance.

A comprehensive approach to computing and networking resources in a Cloud environment is necessary due to the significant role that networking plays in Cloud computing. In order to realize this vision, the underlying network infrastructure must be opened and made available to cloud applications at the upper layer; thereby making it possible for Cloud service provisioning to utilize combined management, control, and optimization of computing and networking resources. A composite network-Cloud service provisioning system emerges as a result of this convergence of networking and Cloud computing systems. Exposure of network functions in a Cloud environment is only possible with the appropriate abstraction and virtualization of networking resources due to the complexity of networking technologies and protocols.

Telecommunication and networking systems, on the other hand, face the challenge of rapidly developing and deploying new features and services to meet the various computing application needs [4].For a wide range of applications to be supported, heterogeneous networking systems must be able to coexist and work together, which necessitates fundamental changes to the Internet architecture. The virtualization of network resources is a promising strategy taken by the networking research community to address these issues. namely, through resource abstraction and virtualization, exposing underlying network functionalities and decoupling service provisioning from network infrastructure. The general term for this kind of strategy is "network virtualization," and it is anticipated that this will be a major feature of the next paradigm for networking [5].

As a potential enabler of profound changes in both computing and communications domains, virtualization is expected to bridge the gap between these two fields that traditionally live quite apart and enable a convergence of networking and Cloud computing. Network virtualization in a Cloud environment allows a holistic vision of both computing and networking resources as a single collection of virtualized, dynamically provisioned resources for composite network-Cloud service provisioning. Convergence of networking and Cloud computing is likely to open up an immense field of opportunities to the IT industry and allows the next generation Internet to provide not only communication functions but also various computing services. Various telecommunications and Internet service providers around the world have already shown a great deal of interest in providing Cloud services based on their network infrastructure. For example, AT&T has launched its Cloud architecture that offers a wide range of enterprise hosting and Cloud computing services1. Verizon has also started offering enterprise Cloud computing services based on its Verizon Cloud Platform2.

The convergence of cloud computing and networking can be seen from both a vertical and a horizontal perspective. Through an abstract virtualization interface, resources and functions in network infrastructure are opened and exposed to upper layer functions in the Cloud in the vertical dimension. These functions include resource management modules and other functions for offering Cloud services. A composite network-Cloud service provisioning system is formed when Cloud data centers that provide computing functions and network infrastructure that facilitates data communications converge in the horizontal dimension. In a Cloud environment, such a convergence enables combined networking and computing resource management, control, and optimization in both dimensions.

The idea of networking and Cloud computing merging must be realized if certain technical issues are to be resolved. Networking resource abstraction, exposure to up-to-the-layer applications, and collaboration among disparate computing and networking systems are essential for network-to-cloud convergence. As a result, the development of a

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mechanism to support effective, adaptable, and scalable interaction among key players in a converged networking and Cloud computing environment—providers of networking and computing infrastructure, providers of networking and computing service, and various applications as customers of composite network-Cloud services—is a significant research issue. Service-Oriented Architecture (SOA) is a promising strategy for enabling network-Cloud convergence when applied to cloud computing and network virtualization.

Effective architectural principles for heterogeneous system integration are provided by SOA. By encapsulating system resources and capabilities in the form of services and providing a loose-coupling interaction mechanism between these services, service-orientation essentially makes virtualization of computing systems easier [6].The Cloud computing paradigms of Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) have all seen widespread adoption of SOA. Encapsulation and virtualization of networking resources are supported by SOA-compliant network services when SOA is implemented in the field of networking. A Network-as-a-Service (NaaS) paradigm is made possible by service-oriented network virtualization, which enables network infrastructure to be exposed and utilized as network services, which can be combined with computing services in a Cloud environment. As a result, the NaaS model might make it much easier to combine networking and Cloud computing.

Web services are currently the primary method for SOA implementation. The distributed computing sector has seen the most development of web service technologies, such as service description, discovery, and composition; Therefore, in order to satisfy NaaS's requirements for network-Cloud convergence, these technologies must evolve. The recent development of an active research area devoted to the application of SOA in networking has attracted significant interest from both industry and academia. Numerous studies have been conducted on important NaaS technologies, such as network service description, discovery, and composition. Telecommunications, computer networking, Web services, and distributed computing are just some of the many areas in which these works are carried out.Even though a few pertinent surveys have been published, such as ample [4], [7], and [8], each of them focuses on a specific area, either telecommunication services or distributed computing systems and Web services.In addition, no discussion of integrating network services in a Cloud computing environment is included in any of them.The primary objective of this article is to conduct a comprehensive literature review that reflects the current state of service-oriented network virtualization for network-to-Cloud convergence. Puting and present a framework of service-oriented network virtualization for network-Cloud convergence. We also give a comprehensive survey on key enabling technologies of the NaaS paradigm for supporting network-Cloud convergence, mainly focusing on network service description, discovery, and composition technologies. Challenges brought in by network- Cloud convergence to these technologies and opportunities for future research in these areas are also discussed in this article. We hope to arouse interest of the research community on this emerging interdisciplinary field, where cross-fertilization among multiple areas may yield innovative solutions that will significantly enhance performance of the future Cloud-based information infrastructure.

II. THE SERVICE-ORIENTED ARCHITECTURE

The service-orientation principle means that the logic required to solve a large problem can be better constructed, carried out, and managed, if it is decomposed into a collection of smaller and related pieces, each of which addresses a concern or a specific part of the problem. Service-Oriented Architecture (SOA) encourages individual units of logic to exist autonomously yet not isolated from each other. Within SOA, these units are known as services [6].

SOA provides an effective solution to coordinating computational resources across heterogeneous systems to support various application requirements. As described in [9], SOA is an architecture within which all functions are defined as independent services with invokable interfaces that can be called in defined sequences to form business processes. SOA can be considered as a philosophy or paradigm for organizing and utilizing services and capabilities that may be under the control of different ownership domains [10]. Essentially SOA enables virtualization of various computing resources in form of services and provides a flexible interaction mechanism among services.

A service in SOA is a module that is self-contained (i.e., the service maintains its own states) and platform-independent (i.e., interface to the service is independent of its implementation platform). Services can be described, published, located, orchestrated, and programmed through standard interfaces and messaging protocols. All services in SOA are independent of each other and service operations are perceived as opaque by external services, which guarantees that external components neither know nor care how services perform their functions. The technologies providing the desired functionality of the service are hidden behind the service interface.

A key feature of SOA is loosely-coupled interaction among heterogeneous systems in the architecture. The term "coupling" indicates the degree of dependency any two systems have on each other. In loosely coupled interaction, systems need not know how their partners behave or are implemented, which allows systems to connect and interact more freely. Therefore, loose-coupling of heterogeneous systems provides a level of flexibility and interoperability that cannot be matched using traditional approaches for building highly integrated, cross-platform, inter-domain communication environments. Other features of SOA include reusable services, formal contract among services, service abstraction, service autonomy, service discoverability, and service composability. These features make SOA a very effective architecture for heterogeneous system integration with resource virtualization to support diverse application requirements.

Has been made for QoS-aware Web services composition, little work particularly addresses the problem of QoS-aware composition between the networking and Cloud computing service domains. Evaluation of end-to-end QoS of composite network-Cloud services is an unsolved issue and there lacks techniques for QoS modeling and analysis that are applicable to heterogeneous service systems. In addition, virtualization of network and Cloud infrastructure exposes system resources through abstract interfaces, which adds complexity to composite service QoS analysis. Balance between QoS optimization, functional satisfaction, and system scalability is also an issue that is worth studying.

The elastic on-demand feature of Cloud services requires dynamic adaptive network service composition. In spite of the active research on adaptive composition of Web services, as summarized in the previous subsection, little work has been reported on adaptive composition of network-Cloud services. Applications of the available adaptive Web services composition technologies in NaaS for network-Cloud convergence would be an interesting topic for future research. QoS-aware composition adaptation brings in new challenges. Adaptation to QoS attributes by monitoring and predicting service performance along the time would also be useful for supporting elasticity of Cloud service provisioning. On the other hand, QoS equivalence and improvement could be a constraint when selecting substitute services in composition adaptation. Fast adaptation algorithms also need to be developed in order to allow composite network-Cloud services to be adaptive to real- time changes in network and Cloud infrastructure. Therefore, QoS-aware adaptive network-Cloud service composition is a challenging problem that offers rich research opportunities.

Security is a very important aspect in NaaS for network- Cloud convergence. Key requirements include description of network service security attributes, specification of user security requests, security-aware network service discovery, and network service composition for meeting Cloud service security requirements. It is important and challenging to develop a comprehensive framework for inter-domain security policy integration and secure network-Cloud service composition. Security has been such an active research topic in both networking and Cloud computing that this area itself deserves a dedicated survey. Therefore, we leave a thorough survey on the security issue of NaaS for Cloud computing to a future paper.

A summary of state of the art of network service description, discovery, and composition for NaaS-based network-Cloud convergence is given in Table I. The table indicates that service description, discovery, and composition technologies have been extensively studied in the Web services area and has attracted research interest in the telecom/networking field as well. However, most of the existing technologies were developed with a focus on a single (either computing or networking) service domain. Although encouraging research progress has been made on NaaS technologies that are applicable to heterogeneous service environments, converged network-Cloud service provisioning that meets the requirements of Cloud computing is still an open issue.

III. CONCLUSION

The significant role that networking plays in Cloud computing necessitates a holistic approach that enables the management, control, and optimization of both computing resources and networking in a Cloud environment, resulting in a convergence of the two. As a crucial feature for the next generation of networking, network virtualization is being implemented in the Internet and telecommunications sectors. Virtualization is anticipated to bridge the gap between these two fields and enable a convergence of networking and Cloud computing as a potential enabler of profound changes in both the communications and computing domains. In cloud service provisioning, the Service-Oriented

Architecture (SOA) has been adopted as an efficient architectural principle for system integration. According to the review that is provided in this article about the most recent advancements that have been made in the provisioning of telecom and Internet service, SOA has been widely used as a key mechanism for achieving network virtualization. As a result, the Network-as-a-Service (NaaS) paradigm may greatly facilitate the convergence of networking and Cloud computing when SOA is applied to network virtualization and Cloud computing. The main implementation method for SOA will be web service technologies, which will serve as the technical foundation for NaaS for network-Cloud convergence. This article provides a survey of key technologies for NaaS, focusing primarily on network service description, discovery, and composition. It reveals that, despite significant progress toward enabling NaaS for Cloud computing, this field is still in its infancy and faces numerous obstacles; as a result, providing numerous opportunities for subsequent research. The performance of the Cloud-based future information infrastructure will be significantly improved by cross-fertilization between multiple fields, such as telecommunications, computer networking, Web services, and Cloud computing. These innovative solutions to network-Cloud convergence could be provided by cross-fertilization.

REFERENCES

[1]. Foster, Y. Zhao, I. Raicu, and S. Lu, “Cloud computing and grid computing 360-degress compared,” in Proc. 2008 Grid Computing Environment Workshop, pp. 1–10.

[2]. K. R. Jackson, K. Muriki, S. Canon, S. Cholia, and J. Shalf, “Per- formance analysis of high performance computing applications on the Amazon Web services Cloud,” in Proc. 2010 IEEE International Conference on Cloud Computing Technology and Science, pp. 159– 168.

[3]. G. Wang and T. S. E. Ng, “The impact of virtualization on network performance of Amazon EC2 data center,” in Proc. 2010 IEEE INFO- COM, pp. 1–9.

[4]. T. Magedanz, N. Blum, and S. Dutkowski, “Evolution of SOA concepts in telecommunications,” IEEE Computer Mag., vol. 40, no. 11, pp. 46– 50, 2007.

[5]. N. M. M. K. Chowdhury and R. Boutaba, “Network virtualization: state of the art and research challenges,” IEEE Commun. Mag., vol. 47, no. 7, pp. 20–26, 2009.

[6]. T. Erl, Service-Oriented Architecture – Concepts, Technology, and Design. Prentice Hall, 2005.

[7]. D. Griffin and D. Pesch, “A survey on Web services in telecommuni- cations,” IEEE Commun. Mag., vol. 45, no. 7, pp. 28–35, 2007.

[8]. V. Issarny, N. Georgantas, S. Hachem, A. Zarras, P. Vassiliadist, M. Au- tili, M. A. Gerosa, and A. B. Hamida, “Service-oriented middleware for the future Internet: state of the art and research directions,” J. Internet Services and Applications, vol. 2, no. 1, pp. 23–45, 2011.

[9]. K. Channabasavaiah, K. Holley, and E. Tuggle, “Migrating to a service- oriented architecture,” IMB DeveloperWorks, Dec. 2003.

[10]. OASIS, “Reference model for service-oriented architecture 1.0. Avail- able: http://docs.oasis-open.org/soa-rm/v1.0/soa-rm.pdf,” Oct. 2006.

[11]. S. Weerawarana, F. Curbera, F. Leymann, T. Storey, and D. F. Ferguson, Web Services Platform Architecture. Prentice Hall, 2005.

[12]. M. Lanthaler and C. Gutl, “Toward a RESTful service ecosystem,” in Proc. 2010 IEEE International Conference on Digital Ecosystems and Technologies, pp. 209–214.

[13]. T. Magedanz, “IN and TMN: providing the basis for future information networking architectures,” Computer Commun. J., vol. 16, no. 5, pp. 267–276, 1993.

[14]. ETSI, “Parlay X 3.0 Specifications. Available: http://docbox.etsi.org/tispan/open/osa/parlayx30.html,” Nov. 2007.

[15]. ITU-T, “Rec Y.2012: Functional Requirements and Architecture of the NGN release 1,” Sep. 2006.

[16]. 3GPP, “IP Multimedia Subsystem (IMS), stage 2, Technical Specifica- tion 23.228,” 2006.

[17]. K. Knightson, N. Morita, and T. Towl, “NGN architecture: generic principles, functional architecture, and implementation,” IEEE Com- mun. Mag., vol. 43, no. 10, pp. 49–56, 2005.

[18]. ITU-T, "Rec Y.2240: Requirements and Capabilities for NGN Service Integration and Delivery Envrionment," May 2006.

[19]. OMA, "Open Service Environment version 1.0. Available