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A Literature Review on Challenges and Effects of Software Defined Networking

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Abstract

Network technologies have always been a crucial part of success for technologies like cloud computing. But due to the slow development of a scalable IT infrastructure, this can lead to issues in competitiveness. Software defined networking (SDN) can thereby counteract such issues by giving new functions to the whole network topology. With SDN, administrators have the possibility to abstract the underlying network infrastructure for applications and network services. The paper reports on the main outcomes of a systematic literature review on challenges and effects of SDN. It shows that most papers address the implementation of software defined networking as a challenge, including factors like vendor lock-in and the general risk of changing traditional network architectures. Attention is also given to security issues arising with software defined networks and the permanent high demand from the end-user combined with the fear of changing traditional networks. Issues dealing with specialized know-how were identified as another challenge category. Effects of SDN are discussed by defining unique features of SDN like decoupling hardware from the software and the global view of the whole network architecture. SDN furthermore affects the management of the network, including changes in deployment of policies, the programmability and maintenance of the network. Economic factors, such as cost efficiency and reduction of costs, are also discussed.

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Keywords: cloud computing; software defined networking; SDN; software defined network; literature review

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1. Introduction

Cloud computing as an alternative to traditional computing technology has become one of the most important ICT topics during the last couple of years[1,2]. In a need to improve the performance of organizations by ICT, cloud computing has already changed their information infrastructure and associated business processes as well as business models[3].

Cloud services in general are evoking new challenges for organizations, such as a higher quality of service or high-security networking. To fulfil the increasing demands of end-users, enhanced virtualization technologies are becoming crucial for success. Throughout this paradigm providers require new solutions to manage these demands. Services from big cloud providers, like Amazon EC2 or Microsoft Azure, are mostly deployed to single enterprises of all sizes and to private customers as well, which can increase the challenge of distributing and controlling the needed resources at the right time. The tremendous increase in demand of cloud services from the view of the customer comes along with energy-efficiency and high-security needs[4].

The currently most widely used definition[5] of cloud computing, the NIST definition of cloud computing[6], distinguishes between the four deployment models (i) private cloud, (ii) public cloud, (iii) community cloud, and (iv) hybrid cloud to describe cloud computing. In an addition to that, the novel term "inter-cloud" stands for a large scale evolutionary leap based on the former cloud deployment models. It can be described as a "cloud of clouds" or a "network of networks". The NIST definition of cloud computing names rapid elasticity as a key characteristic of cloud computing which makes it suggestive of unlimited capabilities available for provision within one cloud. Increased utilization ratio however leads to imminent shortages which can be counteracted by resource pooling with other clouds. In order to fulfil the claim of the NIST definition of cloud computing for high flexibility, rapid scalability, and optimized resource usage, a more advanced information architecture is needed. As a novel and innovative approach, a software defined cloud infrastructure seems to be a promising candidate to provide proper solutions for the following trends and domains[7,8]:

- *Cloud services:* Organizational units that have already adopted public and private cloud services now want self-service provisioning of their applications, infrastructure, and other ICT resources. Taking into account additional security, compliance, and auditing requirements, along with business reorganizations, consolidations, and mergers, this is a complex challenge.
- *Consumerization of ICT:* ICT departments are increasingly confronted with employees using their personal devices such as smartphones, tablets, and notebooks to access corporate applications while on the other side they have to secure corporate data and protect intellectual property. This trend usually is referred to as bring your own device (BYOD).
- *Changing traffic patterns:* Today's applications access different servers across various enterprise data centers before returning the data to the end users device. This creates a lot of additional machine-to-machine traffic that has to be transferred to connecting devices from anywhere, at any time.
- *Big data:* Processing large scale datasets on thousands of distributed servers demands more bandwidth. Additional network capacity is needed within and between the enterprise data centers, distributed across different locations.
- *Internet of Things:* Waiting in the wings, the Internet of Things (IoT) will shortly demand novel infrastructure architectures as well and even more dynamic flexibility and scalability to process the expected bulk of data and to manage its distributed origins.

With these constantly increasing requirements organizations have to be open-minded and reconsider their way of managing ICT infrastructure to stay profitable and cost-efficient. Network technology has therefore become a crucial part of success for cloud technologies[9], but due to the slow development of a true scalable ICT infrastructure, this can lead to issues in competitiveness[4].

Software defined networking (SDN) can counteract issues arising from the network by giving new functions to the whole network topology and therefore "*has the potential to enable ongoing network innovation and enable the network as a programmable, pluggable component of the larger cloud infrastructure*"[10]. It "*provides the network operators and data centres to flexibly manage their networking equipment using software running on external*