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New Advances in Future Network Technologies

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1. INTRODUCTION

Nowadays, Internet has became an indispensable part of our daily life. The network keeps expanding in scales and the network technologies develops rapidly. From the network architecture to the network application, new technologies emerge constantly. For example, Software Defined Networking (SDN) introduces the programmability of network to achieve more flexible network management. Device-to-Device (D2D) communication provides the promising solutions for social applications and content sharing applications in mobile network. Cloud computing and fog computing make it possible to maximize the utilization of network resources.

This special issue is intended to introduce some new advances in the above future network technologies, in which eight high quality papers are presented. There are three papers about SDN including the synchronization of multi-domain controllers, the placement of SDN controller and the traffic scheduling in SDN. Three papers focus on cloud computing, whose topics include the IaaS cloud broker, the fog computing and the architecture of virtual machine storage. Other two papers are about D2D network and multicast network, respectively. The general objective of this special issue is to show the state-of-the-art in future network technologies and to point out the directions of the research on future network.

2. THEMES OF THIS SPECIAL ISSUE

2.1. Software Defined Networking

As an emerging network technology, software defined networking (SDN) attracts more and more attentions from both academia and industry. SDN provides solutions to decouple the network control and the data transmission, which enables the network to become programmable. According to the northbound API provided by SDN controller, people can manage the network more flexibly and implement the network innovation applications more easily. However, the research in the context of SDN is still in its infancy. There are many important issues which should be addressed.

Zou et al. try to address the synchronization problem of multi-domain SDN controllers in their paper "Active Synchronization of Multi-domain Controllers in Software Defined Networks" [1]. In massive data center networks, the single-controller is the bottleneck of the SDN deployment. To improve the scalability and reliability, multi-domain controllers are usually adopted. Within this

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context, the the synchronization of multi-domain controllers should be considered. To overcome the drawbacks of existing PS based synchronization algorithm, Zou et al. propose an active synchronization algorithm which is flexibly triggered by events without considering the effect of time on synchronization. The evaluation results show that the active synchronization algorithm can achieve better load balance with less overhead.

Zhao et al. focus on the problem of SDN controller placement in their paper "Scalable SDN Architecture with Distributed Placement of Controllers for WAN" [2]. A large number of SDN controllers are usually required to construct a scalable SDN architecture for WAN. In this architecture, the network performance should be affected by the number and the location of controllers. To minimize the number of controllers and the link delay between switches and controllers, Zhao et al. propose a novel method of controller placement. In the proposed method, they formulate an Integer Linear Program (ILP) model for controller placement in WAN. Then, they propose a heuristic algorithm as the solution. The numerical simulation results show that the proposed method can achieve better results.

Huang et al. study the problem of traffic scheduling for SDN with Deep Packet Inspection (DPI) proxies in their paper "Traffic Scheduling for Deep Packet Inspection in Software Defined Networks" [3]. With the development of SDN, more and more network function proxies are deployed for flow processing, such as DPI, Firewall, Load balancer. To ensure acceptable performance of DPI proxies in SDN, Huang et al. propose an Integrated DPI Proxy Allocation and routing Determining (IPAD) problem, and then formulate this problem as an Integer Linear Programming (ILP) model with the goal of minimizing the overall latency in DPI. They design a two-phase algorithm to solve the IPAD problem. The simulation results show that the proposed algorithm outperforms existing benchmark algorithms.

2.2. *Cloud Computing*

Nowadays, cloud computing has become a highly demanded service. More and more people accept the "pay as you go" model of computing resources. More and more companies prefer using the cloud services to avoid up-front infrastructure costs. However, there are some new challenges rising with the development of cloud computing, such as the model of cloud broker, the concept of fog computing.

Chen et al. focus on the reservation schemes for IaaS cloud broker in their paper "Reservation Schemes for IaaS Cloud Broker: A Time-multiplexing Way for Different Rental Time" [4]. As a novel service model, the cloud broker coordinates the demand of users with IaaS providers to gain high profit by leveraging the time multiplexing of VM instances and the pricing gap between on-demand billing and reservation billing. To achieve this goal, an effective reservation scheme for cloud broker is necessary. Chen et al. propose an offline and an online reservation algorithms to reduce the cost of cloud broker without partitioning users' rental time. The offline algorithm is based on the demand graph while the online algorithm is based on the history data. The experimental results show that two kinds of proposed algorithms both can reduce the cost of cloud broker.

Yao et al. focus on the solution of cloudlet deployment for cost-effective fog computing in their paper "Heterogeneous Cloudlet Deployment and User-Cloudlet Association towards Cost Effective Fog Computing" [5]. With the development of mobile cloud computing, the concept of fog computing is proposed to bring the cloud facilities closer to mobile users, thereby achieving low communication latency between mobile devices and the cloud. In fog computing research community, it is a big challenge to deploy the cloudlet servers in a cost-effective manner. To address this issue, Yao et al. propose a method of heterogeneous cloudlet deployment. They formulate the deployment problem into an Integer Linear Programming model, and then design a heuristic algorithm to solve it. The evaluation results validate the high efficiency of their method.

Chen et al. focus on the storage architecture with non-volatile memory (NVM) device for virtual machines in their paper "MBSA: A Lightweight and Flexible Storage Architecture for Virtual Machines" [6]. In cloud computing, virtualization technology is a good solution to provide a powerful computing platform. However, virtualization technology is not suitable for data-intensive workloads due to high I/O virtualization overhead. To address this problem, Chen et al. propose a

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memory bus based storage architecture named MBSA, in which the performance of NVM devices is fully explored to improve the storage performance of VMs. Compared with the conventional storage architecture, the MBSA can take full advantage of NVM devices. Experimental results show that the MBSA provides good performance on balancing the write operations to NVM devices with low overhead.

2.3. D2D Network and Multicast Network

Device-to-Device (D2D) is a local short-range communication mode, by which files can be cached and shared among mobile devices within a certain range. Because D2D can be used to reduce the traffic explosion through direct communication without traversing the base station or core network, D2D sharing is viewed as a promising application of mobile social networks. To provide better quality of experience for D2D sharing, Wang et al. try to design and implement a big data processing platform to analyze the empirical trace data from D2D sharing application in their paper "A Measurement Study of Device-to-Device Sharing in Mobile Social Networks Based on Spark" [7]. They get a large-scale trace dataset from Xender, which is one world's leading D2D sharing application. Then, they build a big data processing platform based on Spark to explore the characteristics of application and users. Finally, they discuss the potential methods to improve Xender's quality of service.

Multicast is usually used to deliver the same content from a single source to a set of destinations. By multicast, the unnecessary duplicated transmissions can be reduced to save bandwidth efficiently. Although it is a traditional group communication method, multicast faces new challenges from some emerging Internet applications. For example, the problem of uncertain multicast is usually caused by content replica design in content distribution network (CDN) and datacenter network (DCN). Ren et al. try to address the packing problem of uncertain multicast to minimize the total transmission cost in their paper "The Packing Problem of Uncertain Multicasts" [8]. To give effective solution of network resources sharing when a set of uncertain multicast occupy the network simultaneously, they formally present the packet problem of uncertain multicast. Then, they prove this problem is NP-hard and design two greedy algorithms approximating the optimal solution. Finally, they conduct large-scale simulations to verify the effectiveness and efficiency of the proposed algorithms.

3. CONCLUSIONS

In this special issue, there are eight high quality papers about recent advances in future network technologies. From these papers, we can see that SDN, Cloud and D2D remain promising technologies of future network. With the development of these technologies, there are many important issues which need to be addressed. Moreover, we also can see that innovative Internet applications bring new challenges to traditional network technology, such as uncertain multicast in CDN or DCN. These new challenges should be addressed to promote the development of future network. We hope that the readers can benefit from this special issue.

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