Research on Identification and Control of Network Traffic Based on SDN Technology

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Abstract. SDN technology implements network deployment/management flexibility and network resource virtualization by the separation of the control plane and forwarding plane of the network. However, SDN technology faces the same problems as the traditional network does, that is the network can't recognize the network traffic characteristics. Therefore SDN can't achieve automation of network management and deployment. Based on the analysis of SDN technology, the related key technologies of SDN network traffic identification and network control mechanisms are analyzed and finally the possible research direction on the SDN intelligent traffic identification and control are given out.

Introduction

Software Defined Network has been widespreadly concerned in industry and academics. It originates from OpenFlow technology which is proposed in 2008[1]by Stanford University. The basic principle of OpenFlow is to separate the network control functions from its forwarding capabilities. The network equipments do packet forwarding according to its own flow table and the controller manage the flow table of equipment by flow table operation of adding, modifying, or deleting. At the same time, with the controller opens its function to users by application programming interface, the administrator can develop various applications to implement flexible deployment and management of network based on their needs. The open, centralized software control mode will give impact on current network architecture [2], thus, network applications which is built on current network are bound to evolve as well.

Compared with traditional network architecture, SDN has the following characteristics:

(1) Separating control function from forwarding function;

(2) Be flexible managed and configured by software using SDN open API;

(3) Network functions virtualization and more flexible network deployment;

(4) Simplify network management by using controller to manage and control global or part of the network.

While it also has to face the same problem which is the lack of intelligent application-aware capabilities as traditional network does. The controller can't recognize the specific characteristics of traffic flow which is used to optimized network traffic, network management and security control.

Traditional DPI technology achieve a simple flow control such as restrictions on the flow rate of P2P applications based on the different flow characteristics of the application by using TCP protocol mechanisms (such as the size of the TCP sliding window) . The lack of such network traffic management mechanism is: control mechanism which just slows down or resets the traffic is too simple to fine-grained control different applications network flow based on their type. For example, how to provide sufficient resources for detected video applications? How to achieve load balancing between data center servers? Therefore, SDN network needs such as DPI technology to better achieve load balancing, network QoS / SLA assurance, traffic isolation applications. Therefore, how to combine the SDN control capabilities with DPI technology to provide more flexible network management currently is an important research.

SDN network deployment

Currently, Google has deployed SDN wide area network in its internal network to connect their data centers. By using SDN technology, almost 100% bandwidth utilization, elasticity traffic demand, load balancing and control of network and edge servers are implemented [3]. Cisco also raised its Open Network Environment SDN solution [4], which provides onePK suite of development tools, and plans to support SDN features in future hardware products. Tencent and other China Internet companies are also actively studying SDN technologies to achieve traffic management control and flow-demand scheduling. Domestic carriers companies are also actively study and discuss how to apply SDN technology in the data center construction, metro backbone network, access network scenarios as well as the role and methods of SDN network plays in the future network evolution. Georg Hampe [5] etc has studied how to apply SDN in telecommunications network. Traditional telecommunications network uses a large number of tunnels or gateway node connected by overlay networks, which leads to high operating costs and a single point of failure defects. The author extends SDN concept to increase the robustness and flexibility of the network by using vertical forwarding technology and controller to replace these gateway nodes. Vertical forwarding allows cross-layer packet forwarding, such as IP forwarding between the IP layer and its upper layer overlay network. The author also discusses how SDN technology is applied in mobile IP networks, UMTS and DSL networks.

SDN network traffic management

At present, researches on management of network traffic are as followings:

SDN network resource management and optimization:

N. Koutsourisd et al [6] demonstrated a GUI prototype which uses unified management framework (UMF) to manage and optimize SDN network resource. Network managers can use this tool to optimize resource allocation and network traffic according to the actual needs ,but it did not describe the specific optimization algorithms.

SDN traffic engineering:

Ali Reza Sharafat et al demonstrated the method of using OpenFlow and NOX technology [7] to implement the WAN MPLS traffic engineering, the test bed of which, including software and hardware switch which is controlled by MPLS-TE Controller service running in the controller.

SDN flow isolation/migration:

Adrian Lara et al [8] use SDN technology to dynamically manage VLAN network in order to achieve network flow dynamic isolation, while using OpenFlow to isolate network traffic according to whether encryption is required,for example, the network traffic that need to encrypt will automatically be forwarded to the encrypt server before forwarding. This method takes preliminary tests for basic scenario, but how to effectively isolate the traffic in large-scale network was not performed. OMNI [9] provides a multi-Agent traffic monitoring and traffic configuration functions which is based on OMNI API. This method provides operation for flow forwarding rule and flow migrate north interface to applications.

SDN based traffic steering:

In SIMPLE-fying[10], traffic steering is implemented by policy enforcement layer based on existing network middlebox and SDN. User-specified policies will be automatically converted into data plane forwarding rules with capability of load balancing for traffic steering.

intelligent application-awareness and SDN

Big Switch combined SDN technology with DPI [11] to achieve cloud data center security services, but specific details of its solution temporarily are unable to understand. Guohui Wang [12] studied management of network topology and routing on the optical switching network based on SDN technology according to the big data applications characteristics. The key to this method lies that it manages network depending on the application characteristics and its purpose is tightly integrated network with application together. It has following characteristics: analysing traffic patterns of Hadoop big data applications and estimate traffic demand of Hadoop tasks;

Application-aware SDN controller;Hadoop task scheduling with network-awareness.However, the methods optimizes network management according to application characteristic which is analysed manually, which lacks intelligence and flexibility.

Atlas [13] proposed method which integrates machine learning-based application-aware technology into the SDN for fine-grained flow control.It uses distributed architecture, collects network status information from network access point by using mobile agent technology and performs machine learning algorithms to identify the application type and then perform appropriate policies on the application traffic.This method has following characteristics: small amount of computation, identifying encrypted data stream and has been just only tested for mobile terminal applications currently.

Qosmos*DPI technology [14] applies DPI technology to the virtual network-based architecture, which is characterized by one DPI traffic identification, multiple use, i.e. that DPI results can be used for load balancing, traffic shaping and security services etc.It adds application characteristics label to identified network flow and then modifies flow table in accordance with forwarding policy. The mechanisms and methods of the technical implementation are temporarily unable to know about and do not propose how to be deployed in telecommunications network.

DPI application model for SDN

Figure 1 shows the intelligent network traffic characteristics identification and management model of SDN. In the figure, SDN switch forwards the network traffic to the flow characteristics identification module to achieve the classification of network traffic, network traffic management applications performs network resources schedule based on classification result and then download the scheduling rules by SDN controller to switch flow table to achieve control of the network.

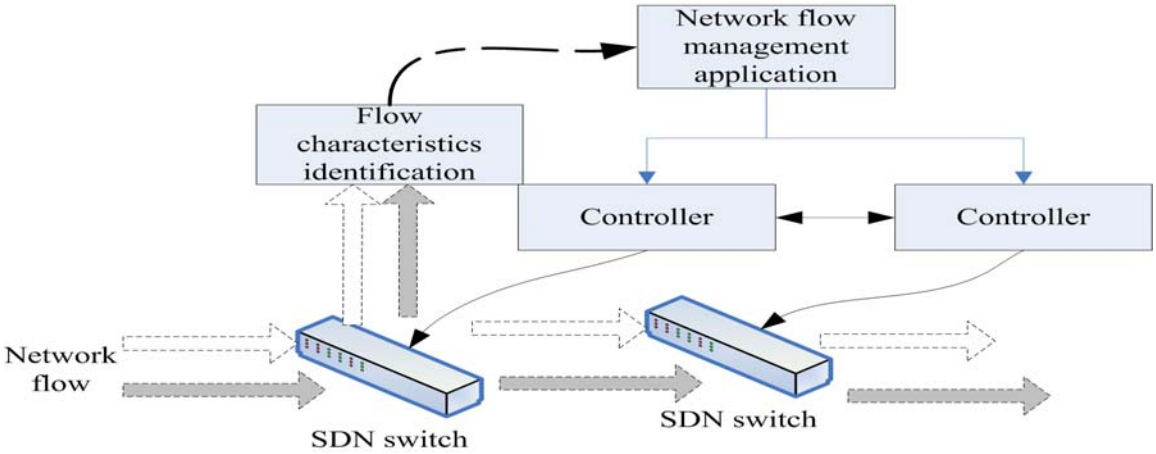

Figure 1

Flow characteristics recognition function can be deployed in following three places: controllers, switches, and application layer. These three methods have their own advantages and disadvantages. Table 1 gives a brief comparison of these three cases.

Deployment place	Embodiment	Performance and Delay	Resource usage
Switch	directly identification of network traffic characteristics	high-level real time performance; low delay	Occupying switch hardware resources
Controller	part of the network traffic is forwarded to controller for characteristics identification	medium-level real time performance; medium delay	Occupying controller resources; Network management and control can be easily performed
Application	part of the network traffic is forwarded to application layer for characteristics identification	low-level real time performance; high delay	Do not take up network resources; Apply different decisions easily for network traffic of different applications accordingly

Table 1

Future research directions

Research of network traffic management and control models based on the identification of network flow characteristics for SDN network architecture.

The main purpose of the application-aware of network traffic is to provide a more effective way for management and maintenance operations. How to use the separation mechanism of SDN network control and forwarding functions and achieve effective management of network traffic is currently one of the key technical problems.DPI technology can effectively identify the types of network traffic and SDN provides the flexibility of network management. How to combine DPI technology and SDN technology to perform dynamic management and optimization of network resources is the key to maximize the interests of operators.Key problems may include: synchronization of SDN controller status and flow table of SDN switch, How to avoid package loss in the process of traffic scheduling and the influence of traffic management on network performance etc.

Research on deployment mode of network flow recognition and management under SDN architecture.

Currently, telecom operators have not deployed SDN technology yet and mainly focus on SDN technology track and experiments. Therefore, it is necessary to analyze and discuss typical telecom application scenarios and research program which is flexible, reliable and easy to deploy under the new network architecture. Analysis, design and research network experiment scenarios.

Choosing part of specific application scenarios of telecommunication network which is massive and complex to take test is the key of whether the SDN technology has actual application promising in future. The experimental scenarios should be chose according to the rules such as requirements priority and gradual promotion.

Summary

Based on the analysis of major studies on the SDN network management technology, we analyzes the necessity of DPI technology and how to improve the flexibility of SDN network management by combing DPI technology and the possible future research directions in SDN and DPI.

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