INTERNATIONAL JOURNAL OF ADVANCE RESEARCH AND DEVELOPMENT

IJARnD

(Volume2, Issue1)
Available online at: www.ijarnd.com

A Review on Network Resource Control and Reconfiguration in SDN

Parvathy Vijayan[1], Manju .R[2]
[1]*M.Tech Scholar, Dept. of IT, Govt. Engineering College, Idukki, Kerala, India*
[2] *Assistant Professor, Dept. of IT, Govt. Engineering College, Idukki, Kerala, India*

ABSTRACT

With the evolution of communication technologies and the emergence of new services and applications, developing approaches for the network resources management with minimum human intervention has become a key challenge. To meet the requirements of emerging services the future Internet is needed to be more adaptive reactive with respect to network conditions. Resource management and control in Software Defined Network (SDN) is one of the hot topic nowadays. For achieving efficient and adaptive management and control, it should consider both static as well as dynamic scenario and that require a distributed controller approach. Load balancing and energy efficiency is also addressed as part of efficient resource management.

Keyword: Software Defined Networking, Adaptive Resource Management, Load balancing, Energy Efficiency.

1. INTRODUCTION

Software Defined Network(SDN) is an emerging novel approach in the computer networking field which permits network administrator to manage the network services through the extraction of lower level functionality, i.e., to manage traffic from a centralized control without touching individual switches, by separating the control layer from the data plane. The SDN architecture is shown in Fig 1.

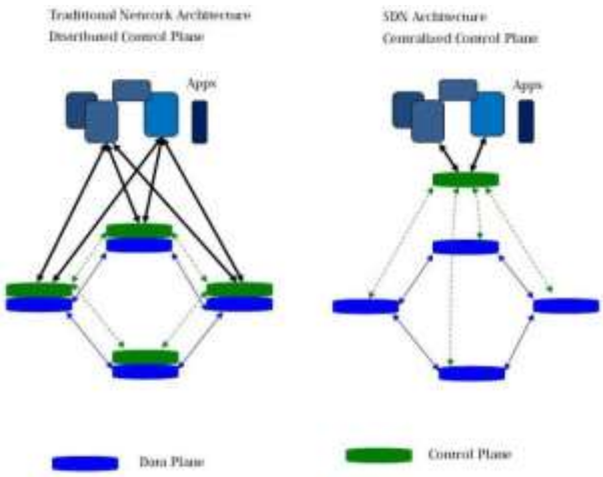

Fig 1: Software Defined Network vs. Traditional Network

Figure shows difference between traditional network and SDN. Traditional network architecture mostly is time consuming and error prone. When it comes to Software Defined Networking, it offers more configuration accuracy, consistency and flexibility. Another expected benefit of the SDN approach is the optimization of data flows, in which an SDN controller is having the ability to identify multiple paths per flow. The concept of centralized architecture of SDN is the bottleneck which has to address dynamic and scalable nature of SDN.

SDN has been deployed at several areas, ranging from home networks to data center networks. It has many advantages such as flexibility without compromising forwarding performance, high efficiency, cost reduction and ease of implementation and administration. The focus of the survey is to find the best method to identify an energy efficient, adaptive network resource management and control with maximum load balance.

The key parameters while considering the design of a SDN is the controller placement which considers the propagation delay between controller and network devices. Energy efficiency in SDN can be addressed through hardware-based improvements or optimized algorithm. While considering load balancing, the aim is to distribute the traffic load evenly in the network thereby handling the traffic demand in future.

2. LITERATURE REVIEW

A. Controller Placement

The major issue with controller placement addresses the number of controllers needed and where to place them. In existing scenario, controller was placed in a centralized manner.

A solution for controller placement problem is controlling propagation delay [1]. Here the number of controllers that should be placed depends on two latency conditions 1) Average Latency- minimum delay 2) Worst-Case Latency- maximum node to controller propagation delay. For an effective controller placement, number of controllers should between optimizing worst case and average case latencies.

Another solution for controller placement is a framework called POCO (Pareto-based Optimal Controller placement) [2]. In a pareto-optimal solution, improvements can be made to at least one participant's well-being without reducing any other participant's well-being. It provides operators with respect to different performance metrics. It is well suited for small and medium sized networks which uses controller placement solution based on propagation delay [1]. Moreover, this method extended by a heuristic approach for large scale network is mostly less accurate, but yields faster computation times.

In the Capacitated Controller Placement Problem [3] both controller placement as well as load balancing is addressed which considers the load of controllers. A new control placement problem called Capacitated Control Placement Problem (CCPP) is proposed, which reduces the number of controllers required, when compared with that of earlier one. Latency is considered to be the key parameter as it is recommended to minimize the average latency instead of the maximum latency. The minimal number of controllers with a specified radius is found using an Integer Programming model. This algorithm has two phases: Phase I, the lower bound of radius is obtained and Phase II, the radius is increased from lower bound until a placement is found.

B. Energy Efficiency

In SDN, energy saving can be addressed through hardware- based improvements or optimized algorithms. The hardware- based solutions are applied on the forwarding switches, and software-based solutions are applied on the controller.

Traffic aware Energy management approach is based on the condition that, network components are usually not fully utilized. So the network components can turn on or off based on the traffic load requirement. A solution for energy efficiency is correlation among flows [7] and dynamically consolidates traffic flows onto a small set of links and switches in a data center network (DCN) as in Fig 2.

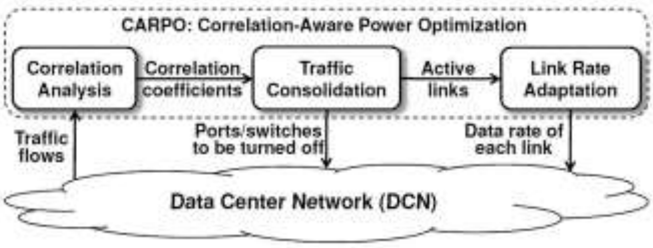

Fig 2: CARPO Framework [7]

It correlate and aggregate traffic flows to the links and switches which later can be shut down when not in use for energy savings. The consolidation is performed with the help of a heuristic algorithm which reduces the computation complexity with acceptable runtime overhead.

Content Addressable Memory (CAM) is a memory that, instead of specifying its address a direct query to the content is possible. Ternary Content Addressable Memory (TCAM) is a high-speed memory that performs an entire memory search in a single clock cycle. Compressing the content of TCAM is a hardware-based solution applied to forwarding switches. Compacting TCAM minimize the memory needed for information storage in forwarding switches. In compacting TCAM solution [8] the size of the flow entries in TCAM is reduced. Shorter tags for identifying each flow is introduced. These packets with shorter tags are routed by exploiting the dynamic programming capability of SDN. However, TCAM is very expensive and power hungry.

End host aware energy saving solutions turn off the underutilized physical servers and running their tasks on a less number of servers in SDN based data centers. It is similar to a traffic aware energy saving approach except that end host aware technique uses the virtualization concept.

Honeyguide [9] is a virtual machine migration-aware net- work topology for attaining energy efficiency in DCN. Reduction in energy consumption is achieved by reducing the number of active (turned on) networking switches. In this approach, the focus is not only turning off inactive switches, but also trying to maximize the number of inactive switches.

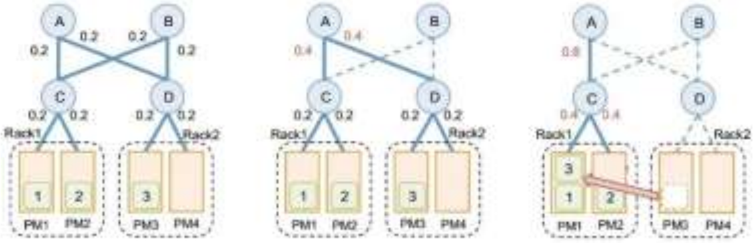

Fig 3:Energy Savings by consolidation [9].

The number of inactive switches are increased by combining two techniques: virtual machine (VM) and traffic consolidation as in Fig 3.

C. Load Balancing

The objective of Load-Balancing (LB) is to balance the traffic load in the network by distributing the load evenly by moving some traffic away from highly utilized network links to less utilized ones.

A solution for load balancing is a self-configuring Traffic Engineering (TE) called, SculpTE [4] approach which uses ECMP routing. In SculpTE load across the network is balanced by adjusting the weights of links by moving traffic away from the most loaded link onto alternate, lightly loaded paths as shown in Fig 4.

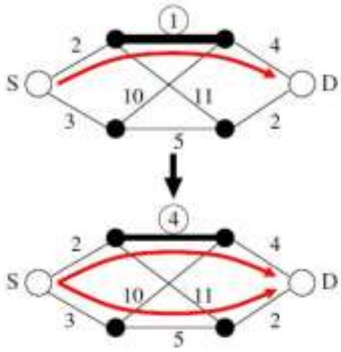

Fig 4: SculpTE[4]

The most loaded link, l, is identified at each iteration and its weight is updated with its key metric which is the weight that required to balance the weight in the link with respect to the alternate path to remove the load from first link for a pair of endpoints.

Adding the key metric to the weight of l increases the cost of the shortest path, equal to that of the cost of alternate shortest path. This enables traffic to be distributed evenly across the equal-cost paths with ECMP.

Another solution for load balancing problem is an intelligent multi-topology IGP (MT-IGP) based intra-domain traffic engineering (TE) scheme[5] which is able to handle unexpected traffic fluctuations with near-optimal performance which re- lies on MTR infrastructure. It consists of two components: 1)An offline link weights computation algorithm-to configure the different topologies 2)An online centralized adaptation algorithm-to dynamically adjust the traffic splitting ratios of the different routing planes.

All the above mentioned cases considered link load balancing. Another load balancing scenario is, considering the load balancing among controllers [6]. A controller pool is there which dynamically grown or shrunk according to traffic conditions and needs, and the load is dynamically shifted among controllers. When the aggregate load changes over time, the system dynamically shrinks or expands the controller pool as needed. Moreover, it discuss about switch migration technique which can be used in dynamic network.

An adaptive resource management approach [10] is proposed as a solution for load balancing, controller placement and energy efficiency, for static as well as dynamic network. In case of a dynamic network, network needs frequent recon- figurations of network resources like switches, links etc. The centralized approach of SDN is required in case of large timescale, for which the time between executions of operations is greater than the execution time, while considering short timescale it fails. So distributed controller is placed with the help of a placement algorithm which result in an architecture as shown in Fig 5.

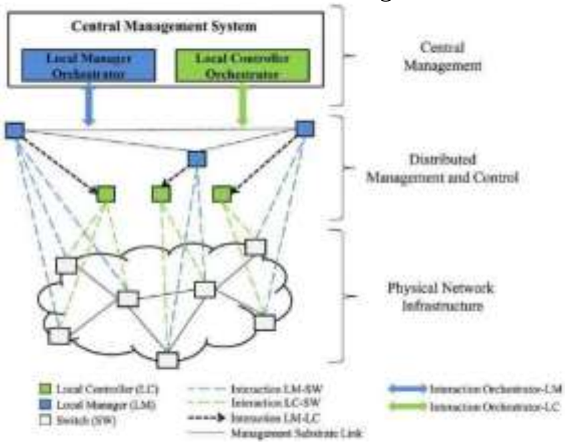

Fig 5: Distributed Controller Framework

Load balancing as well as energy efficiency is achieved with the help of splitting ratios of network resources i.e., by moving traffic from highly utilized link to less utilized links and least utilized Router Line Card(RLC) to most utilized one respectively.

The Table I shows the main features of the controller placement, load balancing and energy efficiency management in different proposals.

Table 1.Comparative Study

Title of the paper	Key Idea	Advantages	Disadvantages
The controller placement problem[1]	Number of controllers are in between average and worst case latency	Can estimate exact number of controllers	Small and medium sized net- works
Heuristic Approaches to the Controller Placement Problem in Large Scale	Pareto optimal placements	Considers small sized as well as large network	Less accurate
On the Capacitated Controller PlacementProblem in Software	Lower Bound of radius is obtained and increased till placement is done	Can obtain the minimal number of controllers	Doesn't considers link load
Autonomous traffic engineering with self-configuring topologies.[3]	Adding Key metric to the most loaded link	Updates a single topology inone iteration thereby prevent reaction to instantaneous traffic	Link with max key metrics isnot considered even if it has highly loaded.

Towards an Elastic Distributed SDN Controller.[4]	Controller pool is dynamically grown or shrunk according to traffic conditions.	Load is dynamically shifted not only when exceeds but also falls below a threshold.	
Adaptive multi-topology IGP based traffic engineering with near-optimal network performance[5]	Offline link weight optimization for achieving maximum path diversity. Measure incoming traffic, compute splitting ratio and instruct	Easiness of identifying the most utilized link	Does not work well with Point- of-Presence topologies
CARPO: Correlation-AwaRe Power Optimization in data center net- works.[6]	Consolidates traffic flows onto a small set of links and switches and then shuts down unused net-work devices	Adapts the data rate of each active link to the demand of the consolidated traffic flows onthat link	Determining the set of network components to turn on or turn off dynamically without affecting QoS andperformance
Com- pact TCAM: flow entry compaction in TCAM for power aware SDN.[7]	Usage of short tag	Reduction in the size of the flow entry and can accommodate more number of flow	TCAM is very expensive and power hungry
Honeyguide: A VM migration- aware network topology for saving energy consumption in data center net- works.[10]	Decreasing the number of active switches by combining twotechniques: virtual machine (VM) and	Meets the fault tolerance requirement of data centers.	Since uses virtualization single point of failure may occur.

CONCLUSION

Resource management approaches usually relies on centralized solutions executed by a manager that has a global view of the current conditions to periodically compute new configurations according to dynamic traffic behavior. Although relatively simple to implement, centralized solutions have limitations in practice, especially in terms of scalability and sometimes result in a lag in the central manager reactions that may result in less optimal performance. In order to over- come these limitations, the proposed framework relies on adecentralized infrastructure with an optimum load balancing and maximum energy efficiency.

ACKNOWLEDGMENT

I would like to take this opportunity to express my profound gratitude and deep regard to my guide Prof. Manju R, for her exemplary guidance, valuable feedback and constant encouragement throughout the research.

REFERENCES

[1] B. Heller, R. Sherwood, and N. McKeown, The controller placement problem, in Proc. HotSDN, Helsinki, Finland, pp. 712, 2012.

[2] H. Shirayanagi, H. Yamada, and K. Kono, Heuristic Approaches to the Controller Placement Problem in Large Scale SDN Networks in IEEE Transactions On Network And Service Management, Vol. 12, No. 1, pp. 4-17,March 2015.

[3] G.Yao, J.Bi, Y.Li, and L.Guo On the Capacitated Controller Placement Problem in Software Defined Networks, in IEEE Communications Letters, Vol. 18, No. 8, pp. 1339-1342, August 2014.

[4] S. Sundaresan, C. Lumezanu, N. Feamster, and P. Francois Autonomous traffic engineering with self-configuring topologies, IGCOMM10,September 3, 2010.

[5] N.Wang, KH. Ho, and G. Pavlou. Adaptive multi-topology IGP based traffic engineering with near-optimal network performance, Networking, LNCS 4982, pp. 654666, 2008.

[6] A.Dixit, F.Hao, S.Mukherjee, T.V. Lakshman, R.Kompella Towards an Elastic Distributed SDN Controller, HotSDN13, August 16, 2013.

[7] X. Wang, Y. Yao, X. Wang, K. Lu, and Q. Cao, CARPO: Correlation- AwaRe power optimization in data center networks, in IEEE Info- com,March 25-30, pp. 11251133, 2012.

[8] K. Kannan and S. Banerjee, Compact TCAM: flow entry compaction in TCAM for power aware SDN, IEEE/ACM Transactions on Networking, vol. 20, no. 2, pp. 488500, Apr. 2012.

[9] H. Shirayanagi, H. Yamada, and K. Kono, Honeyguide: A VM migration- aware network topology for saving energy consumption in data center networks, in Computers and Communications (ISCC), IEEE Symposium on, pp. 460467, July 2012.

[10] D. Tuncer, M. Charalambides, S. Clayman, and G. Pavlou Adaptive Resource Management and Control in Software Defined Networks, IEEE Transactions On Network And Service Management, Vol. 12, No. 1, pp.19-33, March 2015.

