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ANALYSIS OF LINK UTILIZATION USING TRAFFIC ENGINEERING TECHNIQUE IN DATA CENTER NETWORK

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Abstract

Data center networks are driven by intensive application like data mining, web searching and cloud computing. Nowadays, topologies in data center networks applied multi-rooted tree like Canonical Tree, and Fat-Tree. In multipath routing Equal cost multiple path (ECMP) forwarding is used in most of the current data center networks. However, it fails to increased path diversity. Modified data centric routing (DCR) algorithm in a data center environment based on the topologies such as canonical and fat-tree to increase the path diversity over unequal cost link. In proposed new algorithm to increase the link utilization ,efficient load balancing and the effects of increased packet reordering on application performance with MTCP and Packet scatter, can further reduce MLU, increase link utilization through DCR routing and better load balancing, finally increase the overall network performance.

Keywords:

Data Center Routing, Data Center Topology, Multipath Routing, Traffic Engineering

1. INTRODUCTION

Today's largest data centers have hundreds of thousands of servers to provide services across the internet and storage across many thousands of machines. The data center is the central storage infrastructure and the Data Center Network (DCN) is the mechanism for linking big data center computers to conduct online cloud services. The efficiency of the data center network thus dictates the consistency of the cloud computing service. With the large-scale increase of servers in data center network, the probability of server failures is very high, servers fault diagnosis becomes an inevitable measure to ensure a DCN reliable communication [3]. The DCN topology is modeled as a multi-processor system, with servers acting as processors and connecting servers acting as connecting processors. With this clarification, MPP diagnostic techniques can be used to diagnose servers in a DCN [6].

To order to house various applications benefiting from the abundance of such services, data centers have vital infrastructure such as pools, storage and networking. Today, cloud computing platforms, primarily provided by big DCs, play a major role in expanded data traffic on the Internet [10]. The traffic increase creates problems for intra-and inter-data center networks because of the diverse characteristics and unpredictability of traffic produced by these services. Transfer of large numbers of gigabytes of data, and low flow traffic of several kilobytes in DCN is the representation of two aspects [17].

An elephant flow concentration in DCNs can lead to a load imbalance as the equal cost ECMP mapping of the elephant flows to the same path. The load imbalance thus affects other flows which attempt to use the common connection. The disparity will result in packet discards, allowing the discarded packets to be re-transmitted. Retransmission in turn leads to additional latency and degradation of the connecting efficiency [17].

The challenge with coordinating successful routing on virtual networks is, in general, that a typical data center requires many cloud systems. Each of these platforms can use different environments of virtualization with different abstraction levels. Data passes through different virtual frameworks in the data centre. There is a delay in each interface. This is not the case that data movements can be optimally organized. Therefore it is necessary to develop a standardized routing strategy in order for effective traffic routing in the virtual data centre, which is not contingent on the virtualization system, while also maintaining the quality of service to the data distribution flows.

Nowadays, topologies in data center networks applied multi-rooted Fat-Tree topology and Canonical tree. Canonical Tree topology with expensive switches in the higher layers and lower end edge switches that connect to thousands of servers. It shows that can horizontally expand DC architecture for increasing aggregate bandwidth among all communicating hosts by interconnecting a large number of inexpensive commodity switches.

In TE techniques based on a simple link state routing protocol able to provide path diversity in DC networks. The DCR routing algorithm is just such a protocol split traffic along all paths, but penalizes longer paths (i.e. paths with larger sums of link weights) exponentially [12]. It is a Traffic Engineering (TE) technique with hop-by-hop forwarding, i.e. routers running DCR make forwarding and traffic splitting decisions locally and independently of each other. Packets can be forwarded through a set of equal cost paths but the longer paths are penalized based on total link weights along the paths.

In this paper implemented new modified DCR that improved the overall performance of network infrastructure. The network can operate efficiently without congestion and without adding extra networking components and better load balancing on other ways bottlenecked links. The DCR routing reduces MLU and increase the overall network capacity [1].

In this paper implemented and evaluated new algorithm for a DC network environment. The main contributions are: A practical implementation of new algorithm for DC networks. The evaluated fat-tree and canonical DC network topologies. The result indicates that modified DCR algorithm falls only small percent short of optimal TE in DC. At the same time, modified DCR provides performance gain of at least 10% over DCR in such topologies.

The result tends to show that the modified DCR algorithm in this topology increase the DC network link utilization and load balancing, which in turn improves DC capacity.

2. RELATED WORK

In [2], authors analyze the end-to-end traffic patterns in data center networks, and examine temporal and spatial variations in link loads and losses. Delivering full bandwidth between arbitrary hosts in larger clusters requires a “multi-rooted” tree with multiple core switches requires a multi-path routing technique, such as ECMP. Several systems have been proposed for energy-aware DCNs using the strategy of powering off unneeded switches and links [5].

Several scientists from different countries have been interested in researching the issues of path management and ensuring the quality of service in data transmission networks. For example, Smith et al. [18] proposed a multiplatform structure to select optimal parameters effectively and adapt to different communication channel conditions [18]. The question of optimization is posed in the sense of the approach where the design goal is to reduce the transmission energy consumption and the money transmission costs at optimum quantitative quantities. It enables efficient communication and improves the cloud system energy efficiency [15].

Monitoring service quality is equally important. Monitoring and analysis of the QoS infrastructure requires a high level of data processing as well as awareness as to which applications traffic is generated. The solution proposed by Bujlow et al. [19] was based upon the C5.0 machine learning algorithm and the rules governing decision making. A new data collection system focused on the agent methodology has been suggested by scientists. Installed on volunteer machines, client programs gather detailed information about each thread that moves through a network interface and the program name taken from the network sockets definition.

We need to determine the types of traffic in a specific network to define the rules on the routing of network traffic and ensure the quality of service. A number of researchers proposed traffic classification-based approaches [4] [20] in order to achieve this objective. In the field of network management, classification of network traffic plays an important role. This is because the packet filters which carry out program recognition are used on the basis of the classifiers. Determine the pertinence of network resources also on the basis of classification. The gathered knowledge is not used solely for traffic control, but also for automatic intrusion detection systems algorithms [8]. Several studies have been performed in the context of these problems, for example using known port numbers obtained by IANA [9], to classify network traffic. The standard port-based classification approach is however not defined, as multiple applications will use the same port.

Most researchers give a traffic packet description dependent on payload details on [14]. A signature approach can also be used for classifying traffic based on the creation of a signature for every traffic type circulating in the network. However, in terms of time complexity it is a very resource-intensive job to search for regularities with significant traffic flows [16].

Various algorithms of routing take into account various QoS metrics. Algebra routing is the main framework used to study the basic properties of algorithms for QoS routing. The analysis of science sources at the topic of the study demonstrated that: there is currently no effective algorithmic solution for traffic routing, computer system application-oriented accounting topology and communication tasks scheme requirements; existing data flow routing methods can be improved with the QoS requirements being taken into account but the need can be enhanced. This shows the new solutions that the project offers. The design of new methods and algorithms to render the adaptive communication routing in the virtual data center more effective is therefore an important task.

3. PROPOSED METHOD

This study suggests the use of techniques for data mining and machine learning as part of the solution of the problem of managing automated traffic routing in a simulated data center network. Due to the high flexibility of their research with unstructured, constantly evolving and continuous connectivity from various sources (network computers, computer and physical processing nodes), data flows, and the collection of methods is focused. The techniques suggested can also be easily evaluated in real time. This approach enables management decisions to be made with minimum delay about the organization of traffic routes within a software-defined network, which in turn will directly affect the efficiency of the whole virtual data center infrastructure.

The solution to the problem of road identification in a virtual data center overlay network is one of the key aspects to the proposed solution. The route identification problem has been broken down into two consecutive sub-problems in connection with the research. The first is directed at classifying channels of communication for a number of features typical of all superimposed networks in a global data centre. The routes are grouped according to the QoS criteria defined by the current traffic flows at the second stage on the basis of the data received. The aggregated data are combined with current traffic flow information and fed to the neural network input to decide on the appropriate route to select. The solution of the challenge of adaptive routing allows you to establish the goals for creating traffic bandwidths and to lay down guidelines for handling the data center network.

For the technological as well as programmatic reasons, a hybrid solution focused on the shared use of self-organizing intelligent software staff and the virtualization of network operations is suggested in order to coordinate and evaluate effective data collection on the condition of the actual and superimposed communication channels in a central data centre network. It allows the effective storage of channel status data as well as the pre-processing of data directly through network nodes. As part of the solution suggested, program agents exchange information within a community on the channel status and accessible routes and the manager transfers the information that has been collected and analysed to the network controller in a compact form.

This approach reduces the overhead for adaptive traffic control infrastructure by two key factors: combining data resources and analysis nodes in one object to optimize the amount of computer resources used; and the network controller transfers data that is already processed, reducing the amount of technical information that travels through the data centre.

The technical innovative aspect of the proposed solution, therefore, is to establish a hybrid approach that enables network traffic routing in a virtual data center to be tracked based on data mining techniques, taking into account network node status details, communication channels like superimposed networks and QoS traffic specifications.

3.1 DCR ALGORITHM

DCR, packet forwarding is hop-by-hop forwarding and it splits the traffic along all paths but penalizes longer paths exponentially, i.e., routers running make forwarding and traffic splitting decisions locally and independently of each other.in addition packets can be forwarded through a set of unequal cost paths but penalizes longer paths exponentially based on the total link weight, In this protocol algorithm simplicity in path diversity and optimality in minimizing maximum link utilization is nontrivial. So that DCR exploit path diversity (link utilization) and load balance traffic in the traffic is not efficient one through this reduced overall network performances.

3.2 TE FOR DC NETWORKS

TE is a necessary tool used on the internet to select route that make efficient use of network resources. In comparisons, ECMP is the multipath routing used in DC networks, but it fails to increase the path diversity and it is static mapping of flow to paths does not consider current network utilization or flow size and degrading overall switch utilization [13]. Centralized TE techniques, schedules in which track the network matrix and global optimal route with the least utilization will be assigned to the flow using ECMP [13]. In this schedules elephant flow can be exactly detected if the buffer of flow crosses a pre-defined threshold values, but does not consider below threshold values, these flows never be scheduled. In comparison, virtual layer-2 uses Valiant Load Balancing to randomize packet forwarding on a per-flow basis, which is essentially an ECMP mechanism over a virtual layer-2 infrastructure. The DCR is a simple and link state protocol that can achieved optimal TE by splitting traffic not only the shortest paths, but also splitting traffic over longer path with exponential penalization [1], DCR exploit link utilization and load balancing is non-trivial.

Based on the above observations, argue that the performance of current DC networks can be significantly managed to avoid congestion on bottleneck links. Among a large number of available TE techniques, such as [11], we have modified the DCR routing algorithm to provide close to optimal TE for a variety of DC topologies [12]. Modified DCR is a simple and link-state protocol that can achieve optimal TE by using not only shortest paths, but also splitting traffic over longer path with exponential penalization.

3.3 LINK UTILIZATION

Self-stabilizing distributed systems are guaranteed to converge to a desired state or behavior in finite time, regardless of the initial state. Convergence is guaranteed, i.e., after the system is affected by transient faults of unknown scale or nature, it will return to the desired behavior. Hence, self- stabilization is a powerful approach for non-masking fault- tolerance. The actions of each individual node of a self- stabilizing system lead to a global behavior possibly not known to each entity. A node can only evaluate its local view, i.e., its own state and that of its neighbors.

3.4 LOAD BALANCING

A round robin algorithm, but with different proportions of traffic being directed to the back-end nodes. Weights must be defined as part of the load balancer node configuration. The weighted round robin algorithm maintains a weighted list of servers and forwards new connections in proportion to the weight (or preference) of each server. This algorithm uses more computation times than the round robin algorithm. However, the additional computation results in distributing the traffic more efficiently to the server that is most capable of handling the request.

Weighted Round Robin - Pseudo code

//Calculate number of packets to be served each round by connections

For each flow *f* and servers in this architecture are 1Gbps. The host-to-switch links are

f.normalized_weight = *f*.weight / *f*.mean_packet_size min = findSmallestNormalizedWeight

f.packets_to_be_served = *f*.normalized_weight/min

//main loop loop

For each non-empty flow queue f_{min}(*f*.packets_to_be_served, *f*.packets_waiting).times do servePacket *f*.getPacket

Self-stabilizing algorithms-Pseudo code Predicate:inNeighbor(*v*) _9$w^2N(v)$: *w*.status = *IN*

waitNeighborWithLowerId(*v*)_9$w^2N(v)$: *w*.status = WAIT$^{w.id}$ < *v.id*

inNeighborWithLowerId(v)_ 9$w^2N(v)$: w.status =IN$^{w.id}$<*v.id*

Actions:

R_1 :: [status = OUT^:inNeighbor(*v*)]! status := WAIT

R_2 :: [status = WAIT^inNeighbor(*v*)]! status := OUT

R_3 :: [status = WAIT^:inNeighbor(*v*)^:waitNeighborWithLower Id(*v*)]! status := IN

R_4 :: [status = IN^inNeighbor(*v*)]! status := OUT

4. NUMERICAL RESULTS

In this part, we evaluate the proposed algorithms of the Modified DCR is analyzed in terms of load balancing and Minimum Link Utilization.

4.1 MINIMIZATION OF MAXIMUM LINK UTILIZATION

The Fig.1 shows modified DCR MLU performance close optimal to DCR. The protocol deviates only by a small percentage from DCR. The reason for such significant improvement is that modified DCR optimizes distribution of flows such that they are unevenly split over all outgoing paths. For example, if a server wants to transmit to another server in a neighboring rack, it physically has two equal-length shortest paths of three hops. But with DCR the two paths may become unequal (Reflected in the sum of link weights along the path) after optimization. Then, the traffic is exponentially split over the outgoing interfaces.

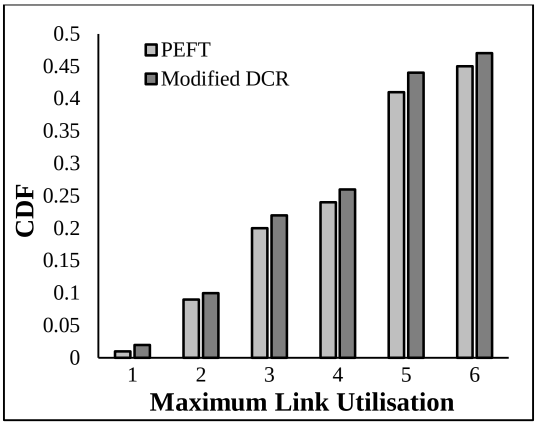

Fig.1. Comparison of MLU for Modified DCR versus DCR

Similar to other TE techniques, DCR needs to measure TM regularly and then update link weight and compute new traffic splitting ratios accordingly. Reactive and sparse TM updates prevent DCR from reacting to changes in a timely manner [1].

4.2 LOAD BALANCING

The Fig.2 shows load balancing for modified DCR vs. PEFT. Performance of the DC network highly depends on the degree of path diversity. DCR, a path based traffic splitting technique, schedules and splits traffic over longer paths to leverage path diversity, and, thus, better load balancing of the distribution of traffic [1].

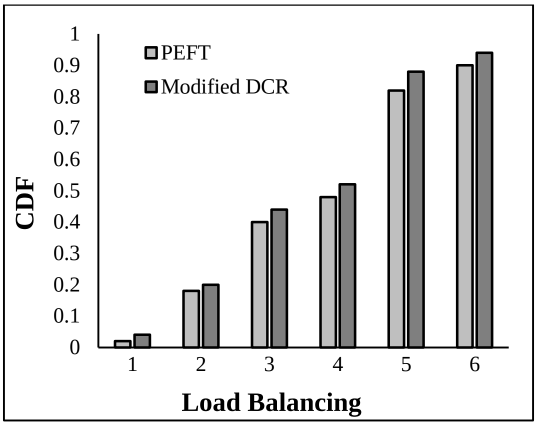

Fig. 2. Comparison of Load Balancing for Modified DCR versus DCR

5. CONCLUSION AND FUTURE WORK

The use of online unequal cost TE as an efficient and viable mechanism to improve load balancing and performance over DC environment. Based on DCR algorithm, protocol forwards packets over multiple unequal cost paths, whereas traffic splitting decisions are independently made based on the total link weight overall reachable paths, and exponentially penalize longer ones. Reliable and in-order packet transmission can be readily achieved through multipath congestion aware protocols, such as multipath TCP and packet scatter .packet scatter is already in use in today's switch. In modified DCR using self-stability and weighted round robin algorithm, including fairer network-wide traffic load balancing, minimizing MLU, and increasing network capacity and efficient link utilization. Finally improves the overall network performances. We must test our methodology in future research using a broad range of code flows, so we can calculate the consistency of the solution proposed. For this function, we prepare a routing algorithm software package that enables us to classify applications and services at the virtual data center and to establish optimized data transmission routes.

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