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A Strategy of Dynamic Routing Based on SDN

Lei Cai, Dianjun Chen and Luyong Zhang

ABSTRACT

Decoupling characteristics of Software Defined Network(SDN) control plane and data plane provides us with a new idea to improve dynamic routing. SDN controllers can easily obtain the global situation of the whole network. The network topology information and bandwidth data are applied to the classical Dijstra algorithm. During the computation of the optimal path, the bandwidth of the path in the entire topology is dynamically updated. Differed from the normal dynamic routing strategy, the routing strategy releases the occupied bandwidth in the shortest possible time according to the transmission delay. The simulation results demonstrate that the dynamic routing strategy can greatly improve the bandwidth utilization and quality of service[1]

INTRODUCTION

Software Defined Network [1] is a new network architecture which separates control functions from data forwarding. In contrast with the traditional network architecture, SDN controllers can precisely monitor the real-time status of the network, and write different processing strategies according to different requirements. Compared to static routing, dynamic routing can update the routing table according to the real-time network status. At present, the research of dynamic routing algorithm [2] based on SDN mainly focused on how to quickly calculate the shortest path [3]. And the route update policy [4] only considers that whole link resources occupied by requests are released after the data is transferred without taking into account the problem that part of the link resource is no longer occupied during transmission, which causes the waste of network bandwidth resources.

[1]Lei Cai, Dianjun Chen, Luyong Zhang, School of Telecommunications Engineering, Beijing University of Posts and Telecommunications, Beijing, China.

To solve the above problems, the improved algorithm takes the bandwidth and network topological graph into account. Meanwhile the paper presents a dynamic routing update strategy [5], which can quickly update the link bandwidth, provide richer link choices for future requests.

NETWORK MODEL

Figure 1 is a model of the realistic SDN network structure, which shows that a SDN controller is responsible for handling requests from many switches. After the initialization of the network, the SDN controller obtains the most original data (topology, bandwidth, time-delay, etc.). The improved routing algorithm runs on SDN controllers. When new requests arrive, controllers calculate the optimal path for new requests and updating the network bandwidth resources.

In this paper, an improved Salam network topology random generation algorithm is implemented. The network topology and data generated by this algorithm are used to simulate the real network situation. The algorithm adopts K mean clustering to control the density of the nodes, so that the topology connectivity and uniformity of the generated network are more close to the real network. The link delay is equal to the node distance divided by 2/3 light speed, which conforms to the actual situation. The resulting topology is shown in Figure 2.

The controller obtains the topology graph $\mathrm{G}=(V,E,B,T)$, $V=\{v_1,v_2,\cdots,v_n\}$ is a set of nodes, where each node represents a switch in the SDN network. $E=\{e_1,e_2,\cdots,e_n\}$ is a set of edges. $B=\{b_1,b_2,\cdots,b_n\}$ is a set of the edge's bandwidth. $T=\{t_1,t_2,\cdots,t_n\}$ is a set of the delay of each edge. $\mathrm{R}=\{r_1,r_2,\cdots,r_N\}$ isa set of all requests. $R_1=\{r_1,r_2,\cdots,r_k\}$ is a set of successful requests. $T_{\mathrm{i}}=\{t_1,t_2,\cdots,t_m\}$ is a set of link transmission delay of r_{i}. B_{i} is the bandwidth required by r_{i}.

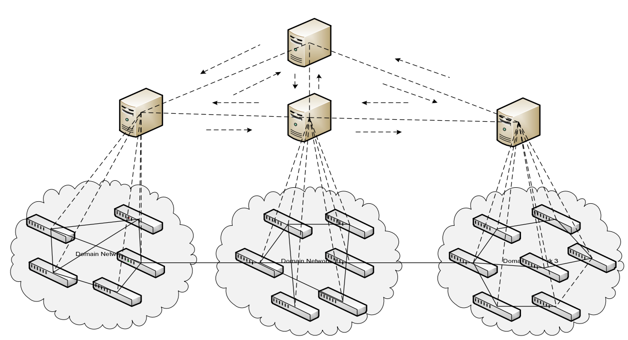

Figure 1. Hierarchical SDN structure.

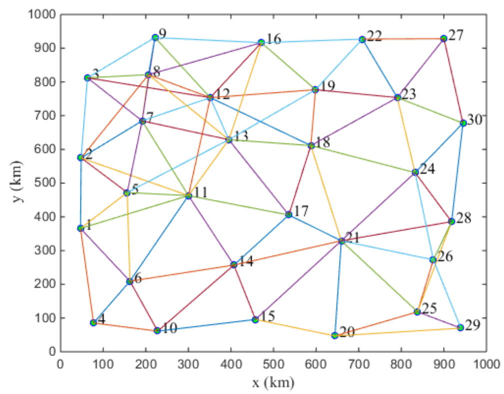

Figure 2. Network topology.

The service rate φ is shown in Equation (1). The bandwidth utilization ρ is shown in Equation (2),

$$\varphi = \frac{\mathrm{k}}{N} \tag{1}$$

$$\rho = \frac{\sum_{i=1}^{\mathrm{k}} \left(\mathrm{B}_i * \sum_{j=1}^{m} t_{\mathrm{j}} \right)}{\sum_{i=1}^{n} b_i * t_i} \tag{2}$$

DYNAMIC ROUTING STRATEGYD

Open Shortest Path First (OSPF) [6] protocol adopts open shortest path first algorithm. Each router in the network calculates the shortest path through the Dijkstra algorithm [7] and writes results to the routing table. As the classic routing algorithm [8] considers only the delay nodes, the link capacity is not considered. In this paper, the time delay and the bandwidth obtained by SDN controllers are all utilized to the classical Dijkstra algorithm [9]. The topology of the network makes it easy for the algorithm to know whether the nodes are connected or not. After calculating the optimal path, resources of link are updated synchronously. The algorithm flow is shown in Figure 3. The algorithm is as follows:

a, Initialization (source node U, destination node V, occupation bandwidth B),the delay from the source point to the all nodes except the source node is infinite, and the predecessor of node path is -1.

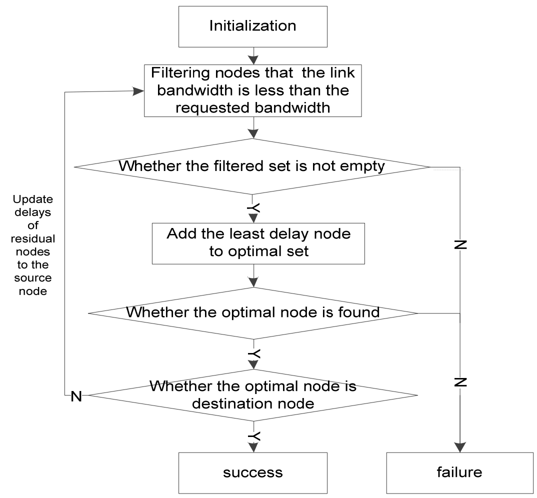

Figure 3. Algorithm flow.

b, Select T from all nodes which the bandwidth of the link from the node to the source node is greater than or equal to B and the delay is minimal. Then add T to the set of nodes that already have found the best path and remove the node from the original collection.

c, T as the central node, update the delay between other nodes and the source node; If the delay from the source point to Tis smaller than the original delay(not via node T), the modified delay value of T should be the sum of the original delay of node U and the delay between U and T.

d, Repeat steps b and c until the destination node V is in the first set

e, Update selected link resources through the above recording optimal path

The paper adopts the improved dynamic routing strategy which makes full use of the programmable features of SDN. The key of the improvement is that the data is transmitted over the part of links before the release of the bandwidth resource occupied by the link between two nodes, which ensures that the next request in the pathfinder process has a better choice.

SIMULATION EXPERIMENT

The 20-nodes network topology is selected to simulate the network structure. The random function generates a large amount of request data to simulate the real data stream. The frequency of the data request is increased from 100 times per second to 1000 times per second. Because the SDN controller is essentially a small server, this paper simulates the SDN controller with the server, runs the Dijkstra algorithm and the routing algorithm on the server, and obtains the final data through many simulation experiments. The simulation results of the bandwidth utilization and the service rate are shown in Figure 4 and 5:

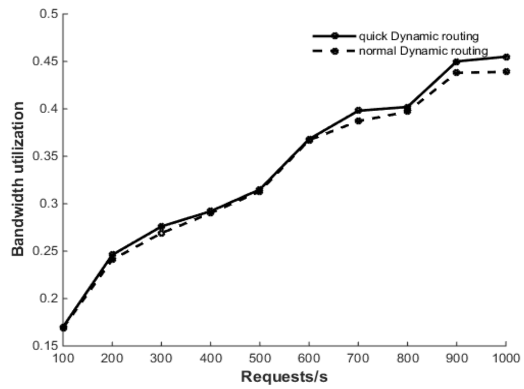

Figure 4. bandwidth utilization curve.

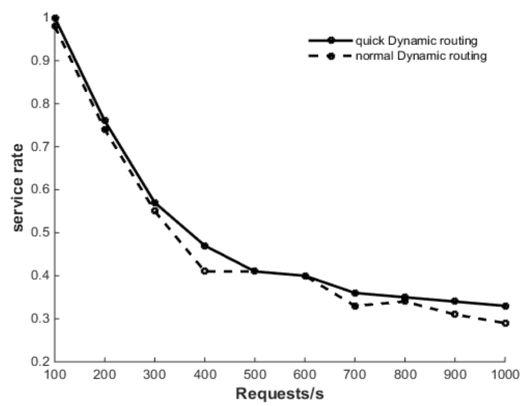

Figure 5. Service rate curve.

CONCLUSIONS

A dynamic routing strategy based on SDN is proposed for improving network resource utilization. It combines the real-time status of the network and the network topology, which makes the algorithm addressing more in line with the actual situation of the network. Meanwhile, the network resource utilization and user service rate have improved from the results. In the case of a large number of requests, it is more obvious. In the future, we can do some further research on the convergence of the algorithm.

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