System Upgrade and Controller Placement for Availability Improvement Based on Optimization Problem in SDN Networks

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1. Introduction

In software defined networking (SDN) networks, the availability should be improved to perform system upgrade and place SDN controllers appropriately. We propose availability upgrade and controller placement for available improvement based on optimization problem in SDN networks. This method extends the method in [1] to upgrade SDN controllers. We investigate the performance of this method.

2. System Model

Figure1 shows an SDN network whose node set is N and link set is E. Let d_{ij} be the distance of link (i, j) between the ith node n_i and the jth node n_j. The maximum acceptable transmission delays are D_{sc} (D_{cc}) between a switch (a controller) and a controller. Furthermore, let λ_a be a lower bound for the availability of each controller and λ_b be a lower bound for the availability of the path between a switch and a controller. The availability α^{x_i} of a controller located at n_i is determined by the level x_i, and the controller can be upgraded to x_i at a cost c^{x_i}. The availability $\alpha^{y_{ij}}$ of (i, j) is determined by d_{ij} and the level y_{ij}, and (i, j) can be upgraded to y_{ij} at cost $c^{y_{ij}}$. The cost of placing a controller at n_i is denoted as h_i.

3. Optimization Problem Formulation

In this section, we formulate an optimization problem for system upgrade and controller placement. In the following,

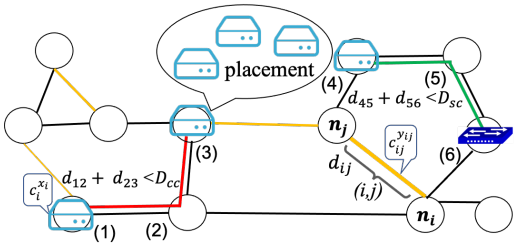

Fig. 1 System model.

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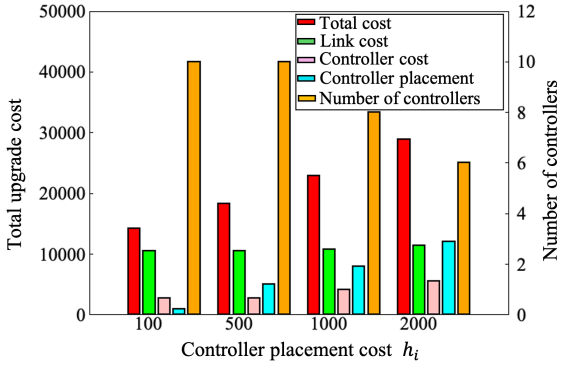

Fig. 2 Impact of cost for placing a controller.

x_i is equal to zero if no controller is placed at n_i, and z_{ij}^{pq} is equal to one if (i, j) is included in the switch-controller paths placed at n_p and n_q. Our proposed method formulates the following optimization problem to minimize the total cost.

$$\min_{x,y,z} \sum_{(i,j)\in E} c^{y_{ij}} + \sum_{n_i \in N} \min(1, x_i)(h_i + c^{x_i}). \tag{1}$$

4. Numerical Examples

Figure2 shows the performance of the proposed method in a case of $D_{sc} = 2{,}117$, $D_{cc} = 3{,}764$, $\lambda_a = 0.999$, and $\lambda_b = 0.9995$. From this figure, we find that the total cost can be minimized to perform system upgrade and place controllers appropriately according to network conditions.

5. Conclusion

In this paper,we proposed a system upgrade and controller placement based on optimization problem. Numerical examples showed that the proposed method can achieve appropriate system upgrade and controller placement.

Acknowledgements

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References

[1] D. Santos, T. Gomes, and D. Tipper, "SDN Controller Placement With Availability Upgrade Under Delay and Geodiversity Constraints," *IEEE Transactions on Network and Service Management*, vol. 18, no. 1, pp. 301–304, Mar. 2021.