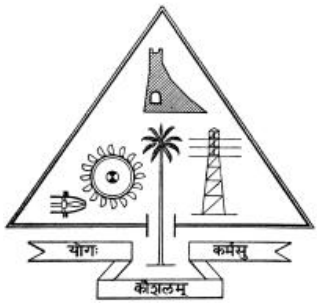
Survey on Controller Placement Problem in Software Defined Network

Amalchithra Stanly

Roll no.: TCR15CSCE02

Guided By: Assoc.Prof. Sminesh C N



Government Engineering College Thrissur
Department of Computer Science & Engineering

07CS 7117 Seminar - 2

Overview

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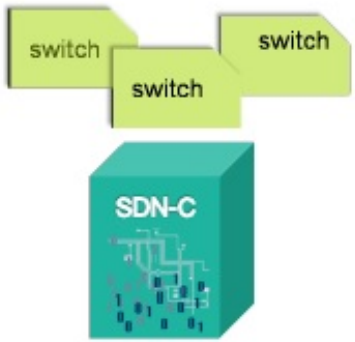
Introduction

- Software Defined Networking: emerging network architecture
- Separates control plane from data plane
- Control plane provides a global view and is programmable

Traditional network



SDN

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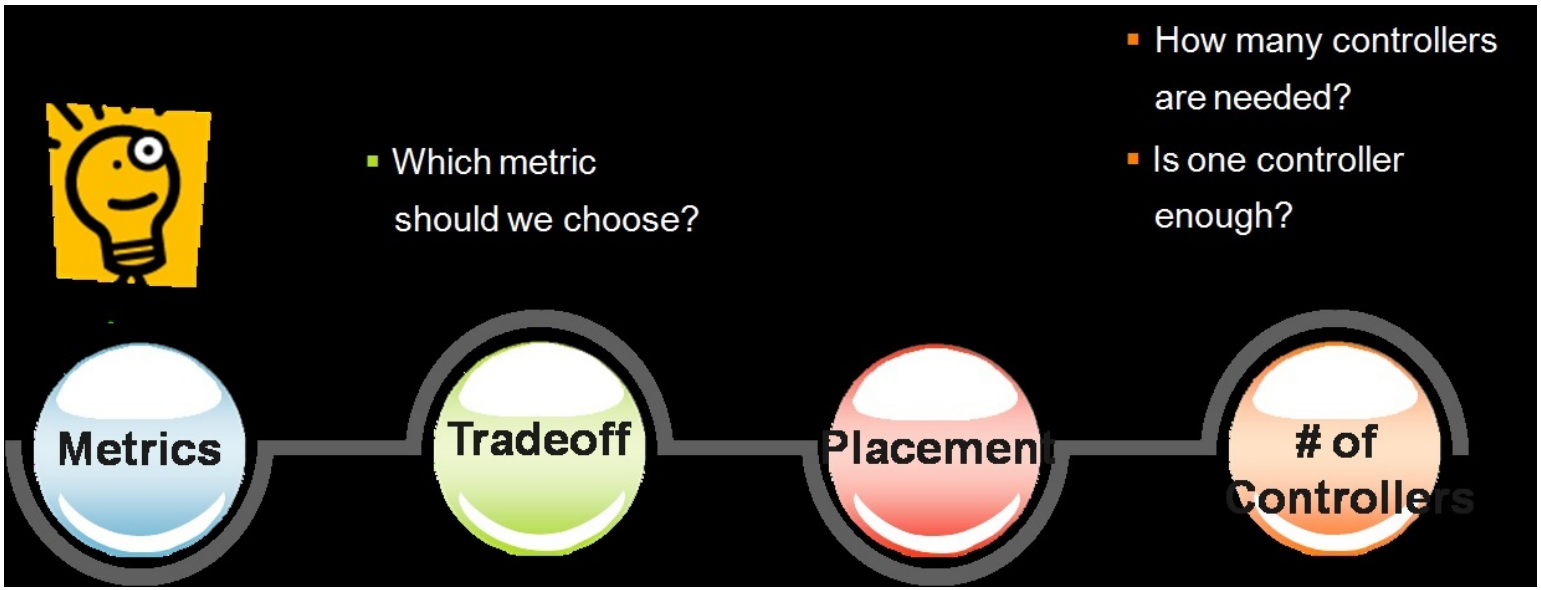
Controller Placement Problem

- How many controllers are needed?
- Where in the topology should they go?



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Controller Placement Problem Solving Methods

Brandon Heller, Rob Sherwood, Nick McKeown, *The Controller Placement Problem* 2012

- First paper about controller placement
- Placement Metric: Propagation latency between controller and switch
- Similar to facility location problem
- Average case Latency
  $L_{avg}(\mathrm{p}) = \frac{1}{|V|} \sum min_{p \in P}\ d_{v,p}$
- Worst case Latency
  $L_{worst}(\mathrm{p}) = max_{v \in V}\ min_{p \in P}\ d_{v,p}$

K- Median Algorithm

- Identify the shortest link d(i; j)
- Selecting node k as a candidate to become a controller, k = i; j, which minimizes the L_{avg}
- Create a cluster by joining nodes v for which d(k; v) 6 Dreq to the selected node k.
- If a node n $\neq$ k exists that minimizes the L_{avg}, it is selected as a controller and the cluster is updated. Otherwise, the node k is selected as a controller.
- After that, the algorithm finds the nearest node to the cluster, repeating the process.
- This algorithm finishes when all nodes are included in a cluster.

K- Center Algorithm

- Select randomly a node k in the network
- Create a cluster with all nodes for which d(k; v) 6 Dreq
- If there exists a node n in the cluster that minimizes the delay to the nodes, it is selected as a controller and the cluster is updated. Otherwise, the node k is selected as a controller.
- Find the furthest node on average to the cluster
- Repeating the process until all nodes are included in a cluster

Controller Placement Problem Solving Methods

Guang Yao, Jun Bi,Yuliang Li, and Luyi Guo:*On the Capacitated Controller Placement Problem in Software Defined Networks*

- This paper considered load on controllers along with latency
- Capacitated controller placement problem
- Why should we consider load??
  - Server capacity limitation
  - Latency of message processing
  - Failure
- Capacitated K- center algorithm can be used for controller placement

Controller Placement Problem Solving Methods

David Hock, Matthias Hartmann, Steffen Gebert, Michael Jarschel, Thomas Zinner, Phuoc Tran-Gia:*Pareto-Optimal Resilient Controller Placement in SDN-based Core Networks*

This paper extended controller placement analysis to include different resilience aspects that are important in the context of SDN Resiliency metrics

- Controller Failures
- Inter-Controller Latency
- Load Imbalance

Controller Placement Problem Solving Methods

- **Resiliency Metrics**
  - Inter-Controller Latency
    - Worst case latency between controllers
      $\pi^{Latency-worst-C2C}(P) = max^{p_1,p_2 \in P}\ d_{p_1,p_2}$
    - Average case latency between switch and controller
      $\pi^{Latency-avg-C2C}(P) = \frac{1}{|P|} \sum d_{p_1,p_2}$
  - Load Imbalance
    $\pi^{Imbalance}(P) = max^{p \in P} n_p$ - $min^{p \in P} n_p$
- Multiple objectives
- Solution: Pareto optimization

Controller Placement Problem Solving Methods

Stanislav Lange, Steffen Gebert, Thomas Zinner, Phuoc Tran-Gia: *Heuristic Approaches to the Controller Placement Problem in Large Scale SDN Networks*

- Multiple objectives
- no single best placement is available
- need to find a balanced trade-off
- Pareto optimal placement performs an exhaustive evaluation of all possible placements
- Heuristic methods are used

Controller Placement Problem Solving Methods

A. Jalili, V. Ahmadi, M. Keshtgari and M. Kazemi: *Controller placement in software-defined WAN using multi objective genetic algorithm*

- Multiobjective cominatroial problem
- Uses NSGA II: approximation of pareto

Controller Placement Problem Solving Methods

Guodong Wang, Yanxiao Zhao, Jun Huang, Qiang Duan, Jun Li: *A K-means-based Network Partition Algorithm for Controller Placement in Software Defined Network*

- Uses network partition to simplify controller placement problem
- For Network partition, K-means clustering algorithm is used

Controller Placement Problem Solving Methods

Peng Xiao, Wenyu Qu, Heng Qi , Zhiyang Li, Yujie Xu: *The SDN Controller Placement Problem for WAN*

- Spectral clustering algorithm is used

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Conclusion

- K- center approach can be used only when latency is considered. It can not be used for multi objective controller placement.
- Pareto optimization gives an optimal multi objective controller placement. But for large networks exhaustive evaluation is needed and it takes more computational time and memory
- So heuristic methods are used for multi objective controller placement. Even though they give solution faster and the need less memory, the solution not accurate. It gives an approximate solution.
- To simplify controller placement, network partition can be used. K- Means clustering can be used for network partition.
- But none of the above approaches give a proper controller placement in the perceptive of load balancing, scalability,and optimal number of controllers.

Thank you!