Politecnico di Torino
Dipartimento di Automatica e Informatica
PhD in Computer and Control Engineering
34th cycle

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Towards Autonomous and Self-Scalable Computer Networks

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1. Introduction

As users and traffic demands grow, the need to optimize our communication networks magnifies, denoting the evidence that networks dictate our technological world and that their complexity increases. At the same time, network automation has been desired in the last years, given the impossibility for human operators to render real-time network management. Recent advantages in artificial intelligence (AI) and machine learning (ML) are paving the path to autonomous and *self-driving* networks: networks that measure, analyze, and control themselves in an automated manner, reacting to changes in the environment and users' demands.

2. Self-Learning Network System

We addressed this problem of providing self-learning capabilities from two different perspectives. On the one hand, equipping the network with the ability to auto-scale the resources up and down in harmony with the traffic demand [1]. On the other hand, using QoE estimation and bandwidth prediction for selecting the best routes using global traffic condition information [2].

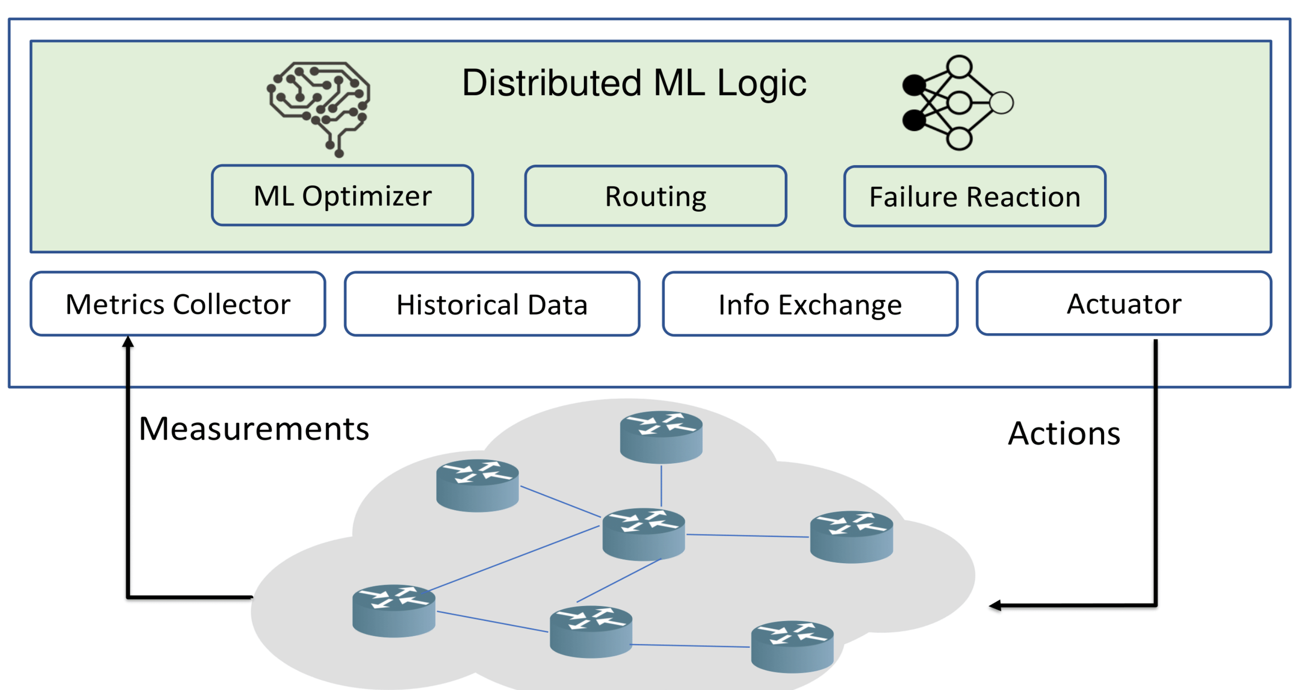

Figure 1. System overview. The (logical) network controller receives in input traffic statistics and outputs network commands.

The advances in softwarization and virtualization of networks enable a fast reaction, with possibly multiple SDN controllers taking decisions autonomously but in a collaborative way (Figure 1).

3. Results

We evaluate the performance of our automation process, showing how effective it is in mitigating network congestion (Figure 2).

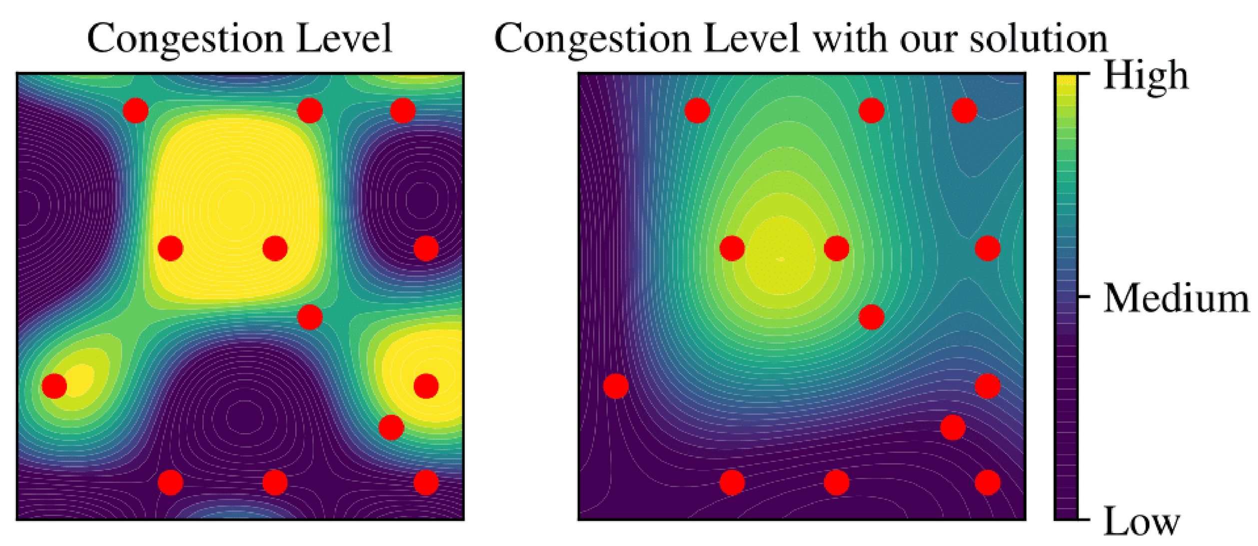

Figure 2. Heat map showing the congestion level before (left) and after (right) the application of our management solution.

In Figure 3 we can see the benefits of this novel approach in overcoming the performance of existing network routing (3a) and network planning applications (3b).

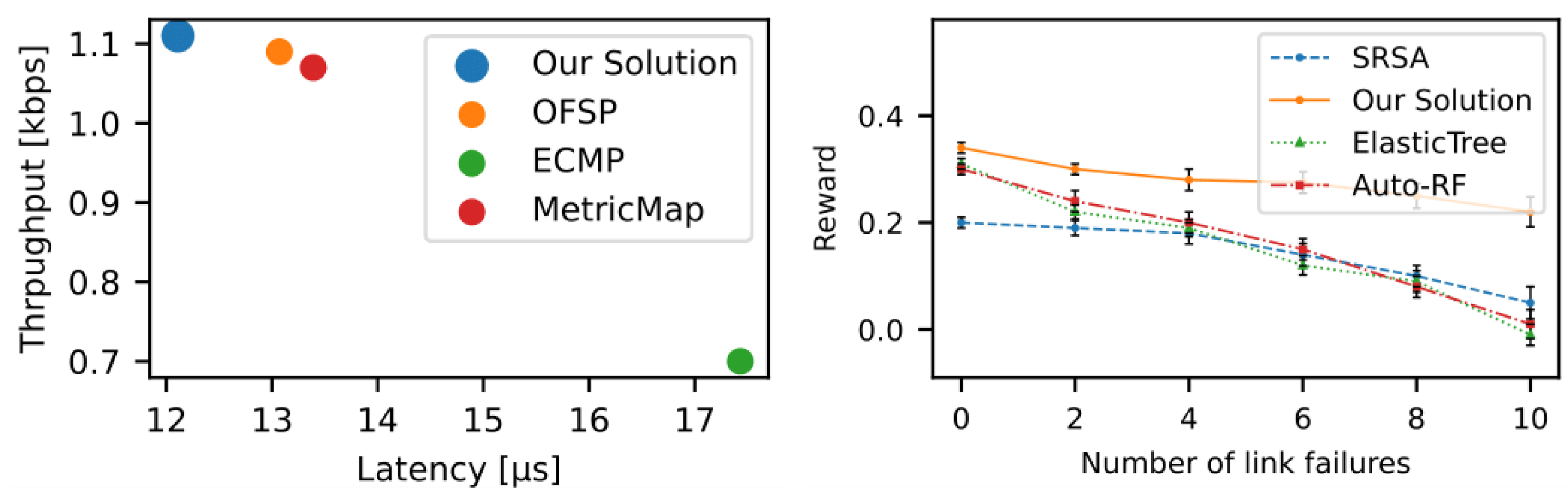

Figure 3. (Left) Trade-off latency and throughput for different routing strategies. (Right) System reward for auto-scaling solutions.

4. References

1. Sacco, A., Flocco, M., Esposito, F., & Marchetto, G. (2021). Supporting Sustainable Virtual Network Mutations with Mystique. *IEEE Transactions on Network and Service Management*, 18(3), 2714-2727.

2. Sacco, A., Esposito, F., & Marchetto, G. (2020). RoPE: An Architecture for Adaptive Data-Driven Routing Prediction at the Edge. *IEEE Transactions on Network and Service Management*, 17(2), 986-999.