Service-centric Segment Routing Mechanism using Reinforcement Learning for Encrypted Traffic

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Outline

- Context
- Service-centric Segment Routing Mechanism
- Experimental Results
- Conclusions

- IP routing approaches [1]
  - TCAM (Ternary Content Addressable Memory).
  - Require more resource consumption [2].
- Segment routing [3]
  - Label switching approach.
  - High traffic load.
  - Performance reduction.

- Segment routing problem: Reinforcement learning task.

- Implementing common segment routing mechanism for various kinds of services is not effective.

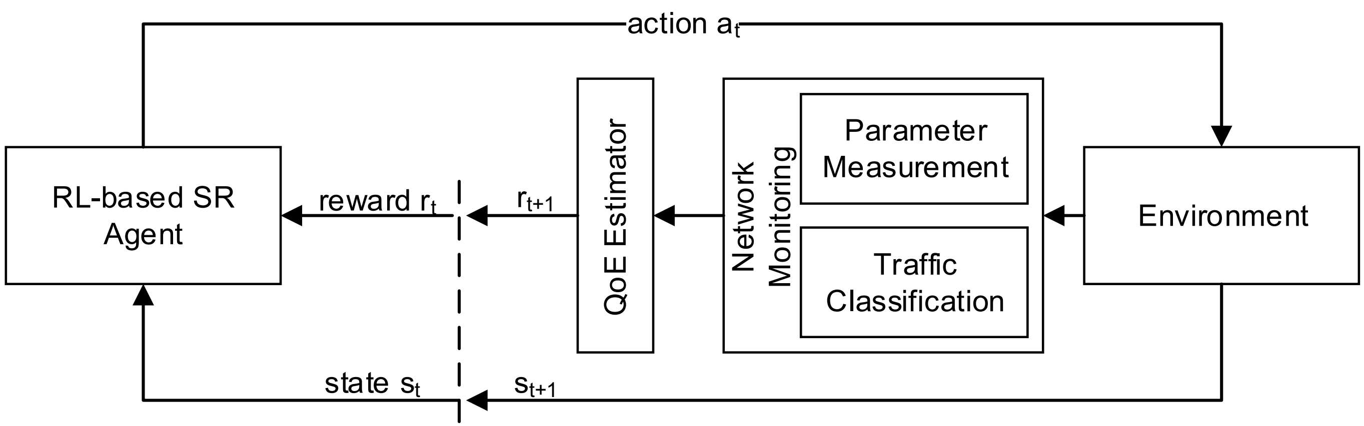
- **A novel service-centric segment routing mechanism using reinforcement learning for encrypted traffic.**

- Class of service

  - Encrypted traffic.

  - Novel traffic classification approach for encrypted traffic [4].

Service-centric Segment Routing Mechanism

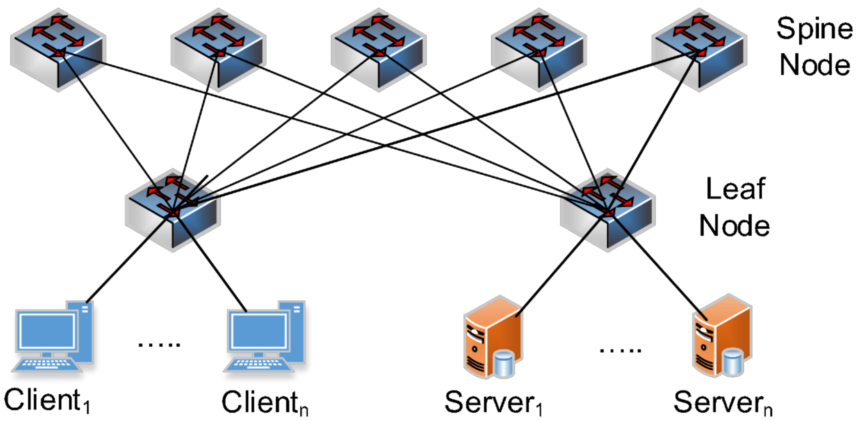


- Reinforcement learning task
  - State: A snapshot of network environment observed by agent.
  - Action: A routing path between source and destination.
  - Reward: QoE of chosen path.

- **Exploration and Exploitation Tradeoff**

  - Balance between the exploration and exploitation phase.
  - MAB problem (Multi-Armed Bandit).
  - Some selection algorithms: Ɛ-greedy, softmax and UCB1 (Upper Confidence Bounds) [5].

- **Simulation scenarios:**
  - Controller ONOS v2.4
  - Mininet v2.2
  - Leaf-Spine topology



  - Link capacity: 10Mbps.
  - High sending rate (60-100 Mbps).
  - The source code of the proposed framework is available at [6].

6. V. Tong, "Service-centric segment routing using reinforcement learning," July 2020. [Online]. Available: https://github.com/vanvantong/rl-sr

- **Proposed service-centric segment routing mechanism (*RL_SR*)**

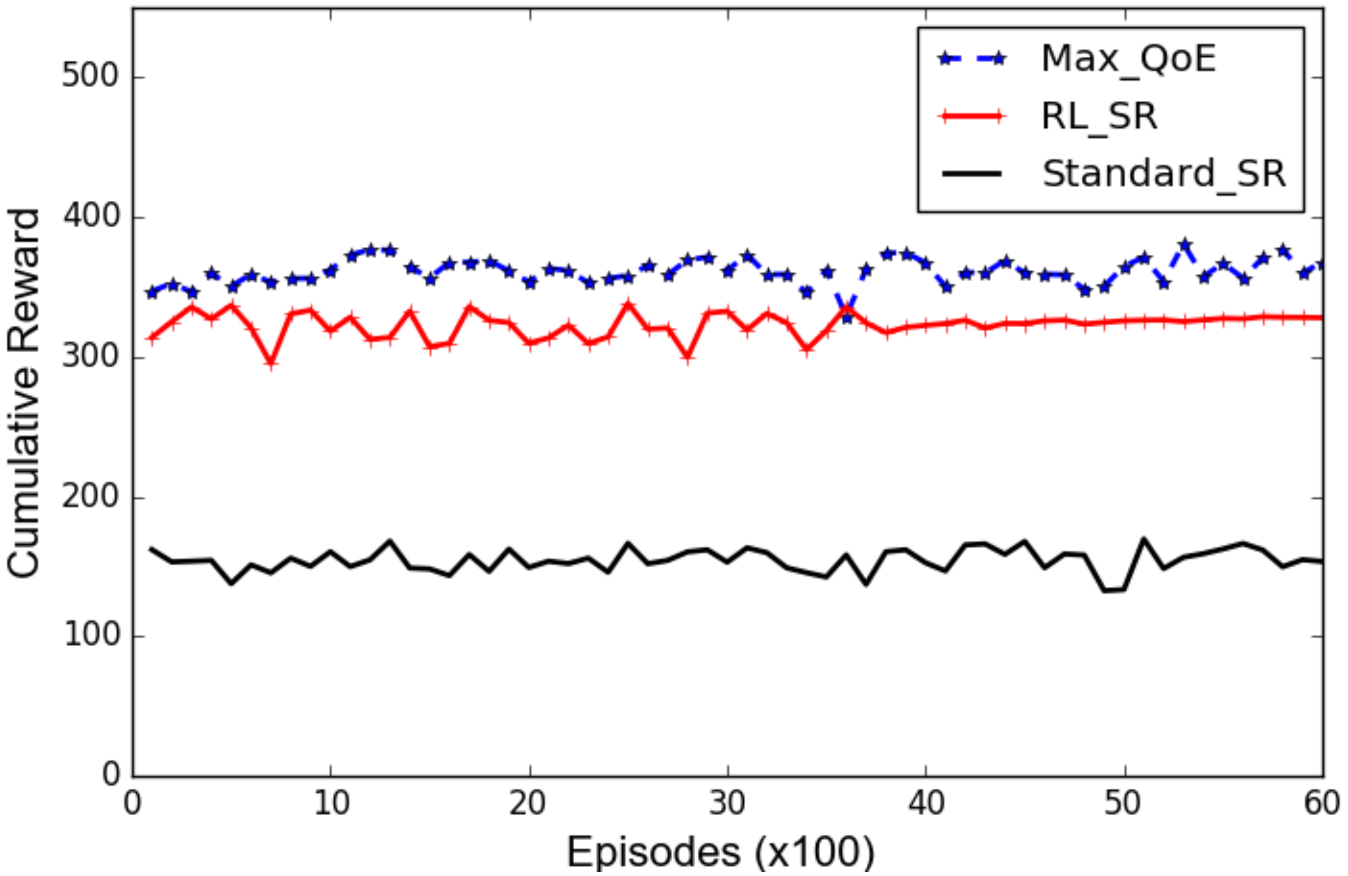
- **Benchmarks**

  - Standard Segment Routing (*Standard_SR*)
  - Segment Routing with maximal QoE (*Max_QoE*)

- **Performance metrics**

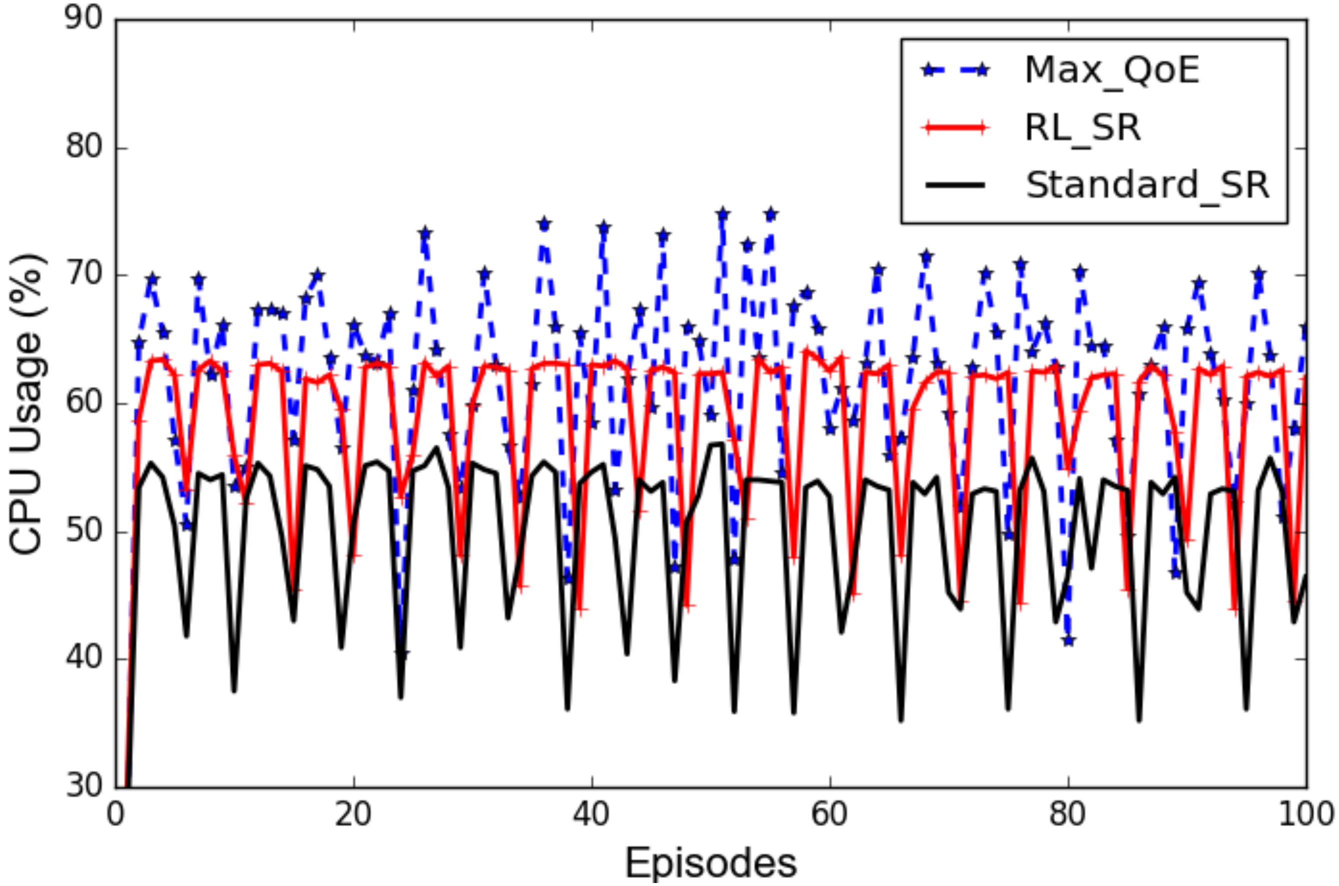
  - Cumulative Reward
  - CPU Usage [7]

- Comparison with some benchmarks



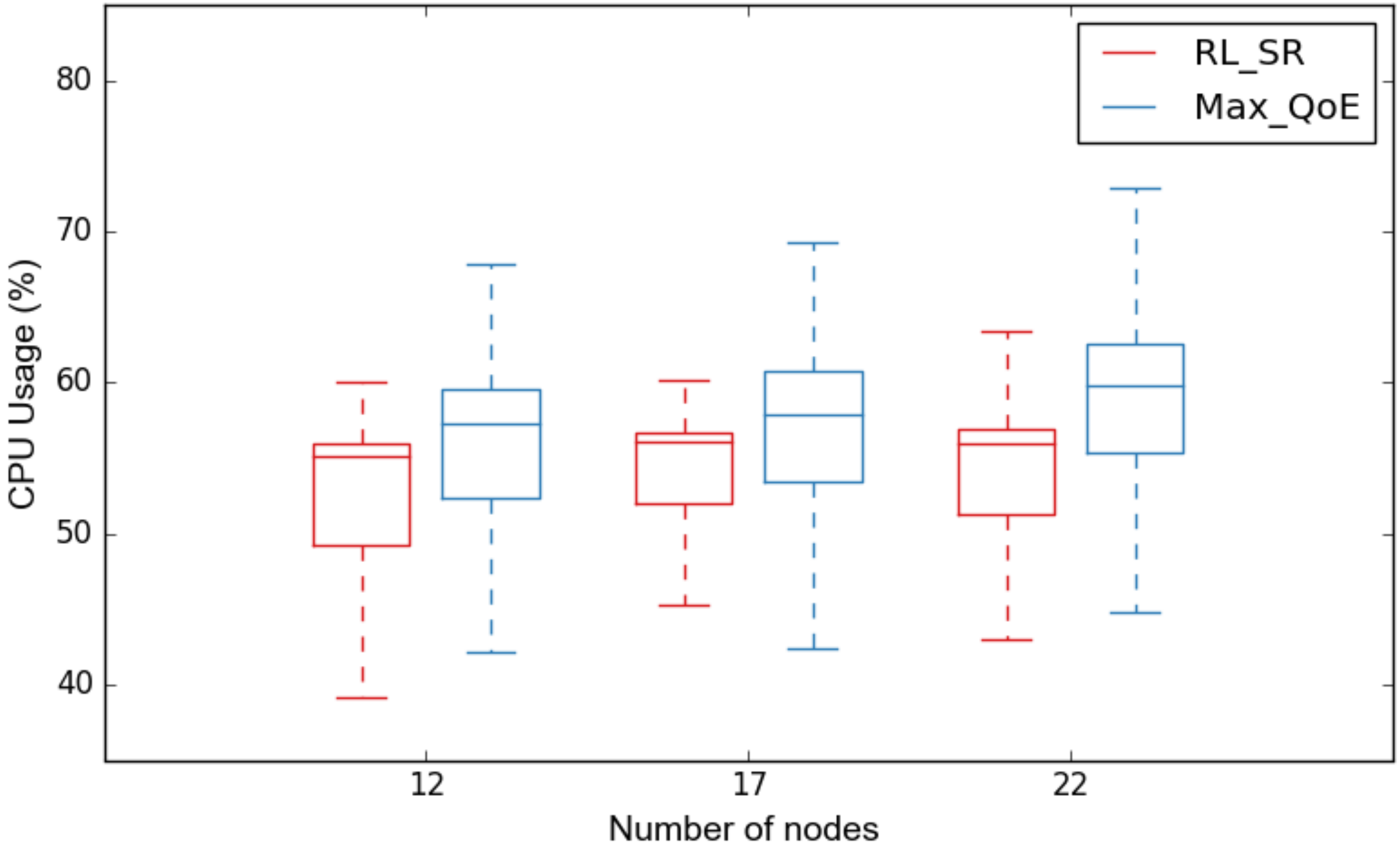
Experimental results

- CPU usage



Experimental results

- CPU usage against Nº node



- In this work, we proposed a novel service-centric segment routing mechanism for encrypted traffic.

- The experimental results show that the proposal obtains better cumulative rewards compared to *Standard_SR* algorithm and reduces 12 percent of CPU usage in comparison with *Max_QoE* algorithm.

- In the future, we will investigate and improve the time complexity of our proposal to perform effectively in large-scale network.

References

1. Jurkiewicz, Piotr, et al. "Testing implementation of FAMTAR: Adaptive multipath routing." *Computer Communications* 149 (2020): 300-311.
2. Barakabitze, Alcardo Alex, et al. "A novel QoE-centric SDN-based multipath routing approach for multimedia services over 5G networks." *2018 IEEE International Conference on Communications (ICC)*. IEEE, 2018.
3. Tang, Fengxiao, et al. "On removing routing protocol from future wireless networks: A real-time deep learning approach for intelligent traffic control." *IEEE Wireless Communications* 25.1 (2017): 154-160.
4. Tong, Van, et al. "A novel QUIC traffic classifier based on convolutional neural networks." *2018 IEEE Global Communications Conference (GLOBECOM)*. IEEE, 2018.
5. Tran, Hai Anh, et al. "QoE-based server selection for content distribution networks." *IEEE Transactions on Computers* 63.11 (2013): 2803-2815.
6. V. Tong, "Service-centric segment routing using reinforcement learning," July 2020. [Online]. Available: https://github.com/vanvantong/rl-sr
7. PyPI, "Measurement for cpu usage." [Online]. Available: https://pypi.org/project/psutil/
8. Adami, Davide, et al. "Towards an SDN network control application for differentiated traffic routing." *2015 IEEE International Conference on Communications (ICC)*. IEEE, 2015.
9. Thales e-Security, Encrypted traffic, https://www.nojitter.com/cisco-malware-detection-what-communications-folks-need-know
10. Wang, Wei, et al. "End-to-end encrypted traffic classification with one-dimensional convolution neural networks." *2017 IEEE International Conference on Intelligence and Security Informatics (ISI)*. IEEE, 2017.
11. Wang, Pan, et al. "Datanet: Deep learning based encrypted network traffic classification in sdn home gateway." *IEEE Access* 6 (2018): 55380-55391.
12. Langley, Adam, et al. "The quic transport protocol: Design and internet-scale deployment." *Proceedings of the Conference of the ACM Special Interest Group on Data Communication*. 2017.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