# Markov Decision Process based Resource Allocation in V2X Communication Networks with Poisson Traffic

Hengxi Zhang[1], Wenbo Ding[1], Ercan E. Kuruoglu[1]

[1]Tsinghua-Berkeley Shenzhen Institute, Tsinghua University

## Abstract

Vehicle-to-everything (V2X) communication networks can satisfy the high efficiency in providing the entertainment applications and the advanced driving service. In this work, the sharing of the spectrum and transmission power in vehicular networks is modeled as a resource allocation problem. In summary, the main contribution of this work are as follows:

- A Poisson traffic is proposed for testing the efficiency of V2X communication network.
- A reinforcement learning algorithm based on Markov Chain is designed to maximize the capacity for high bandwidth content delivery and improve the payload delivery reliability.
- A neural network named Deep Q-Network (DQN) with experience replay is established for improving the performance of Q-learning in reinforcement learning.

## Communication Network Model

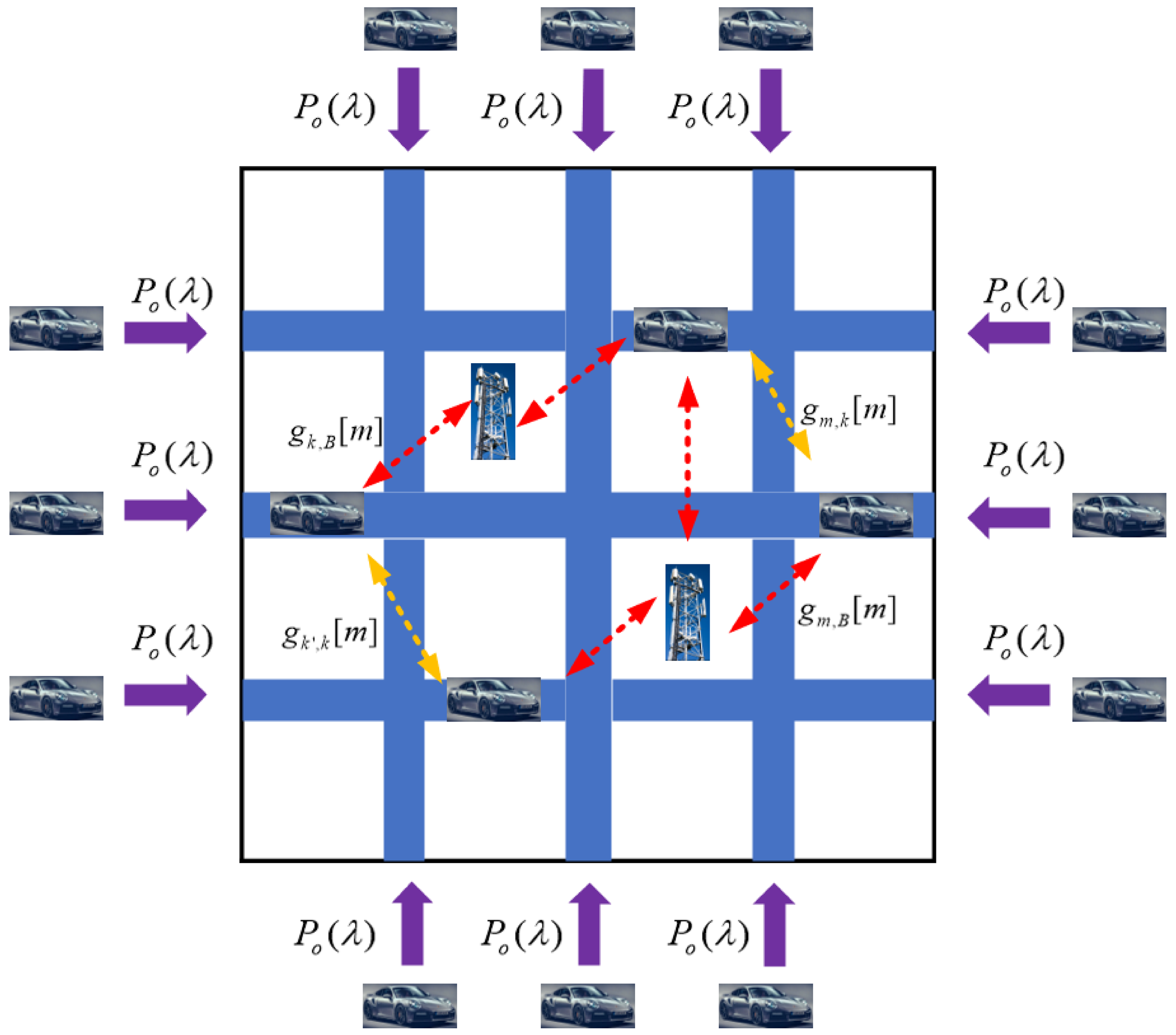

Fig 1. Traffic Network with Poisson Traffic

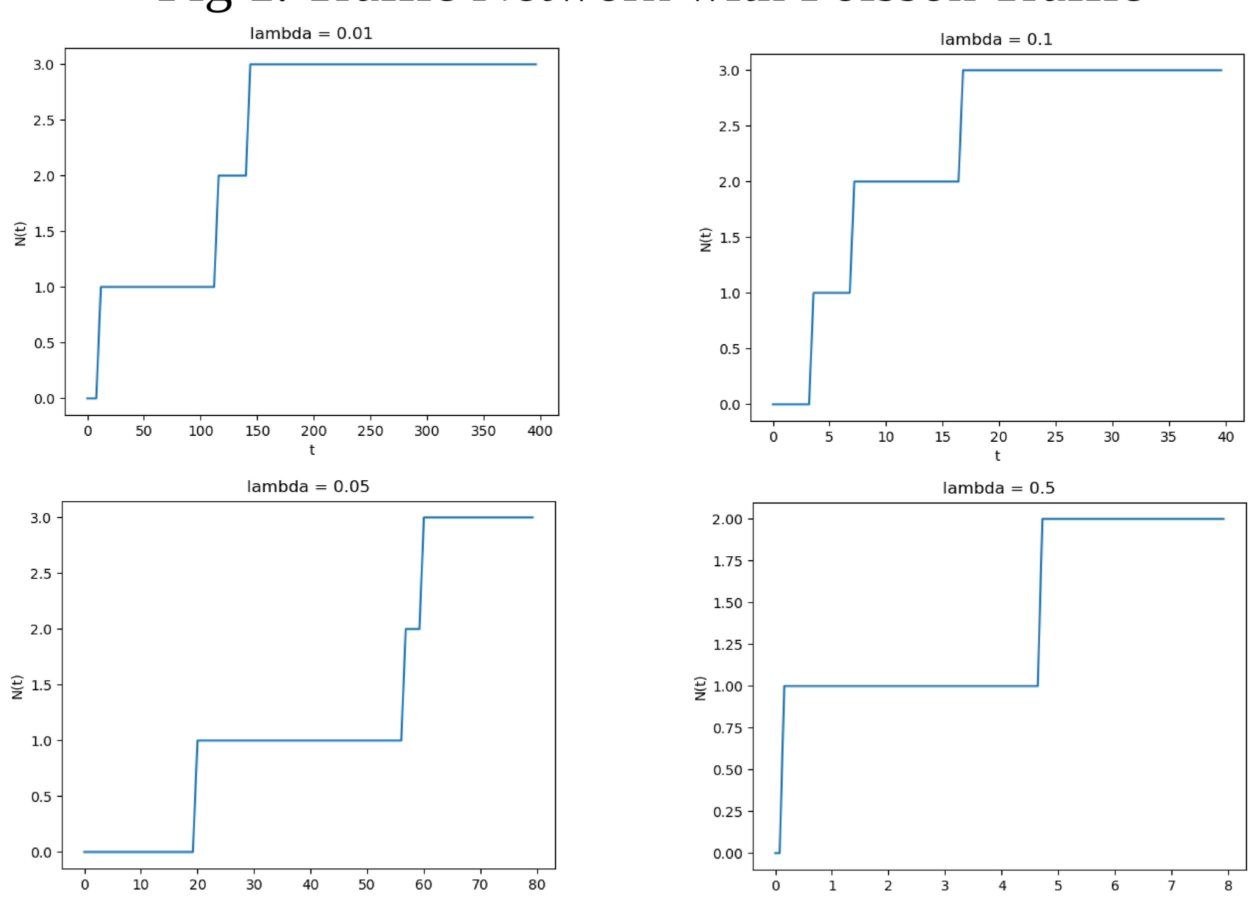


Fig 2. Poisson Processes with $\lambda$ = 0.01, 0.05, 0.1, 0.5

## Markov Decision Process

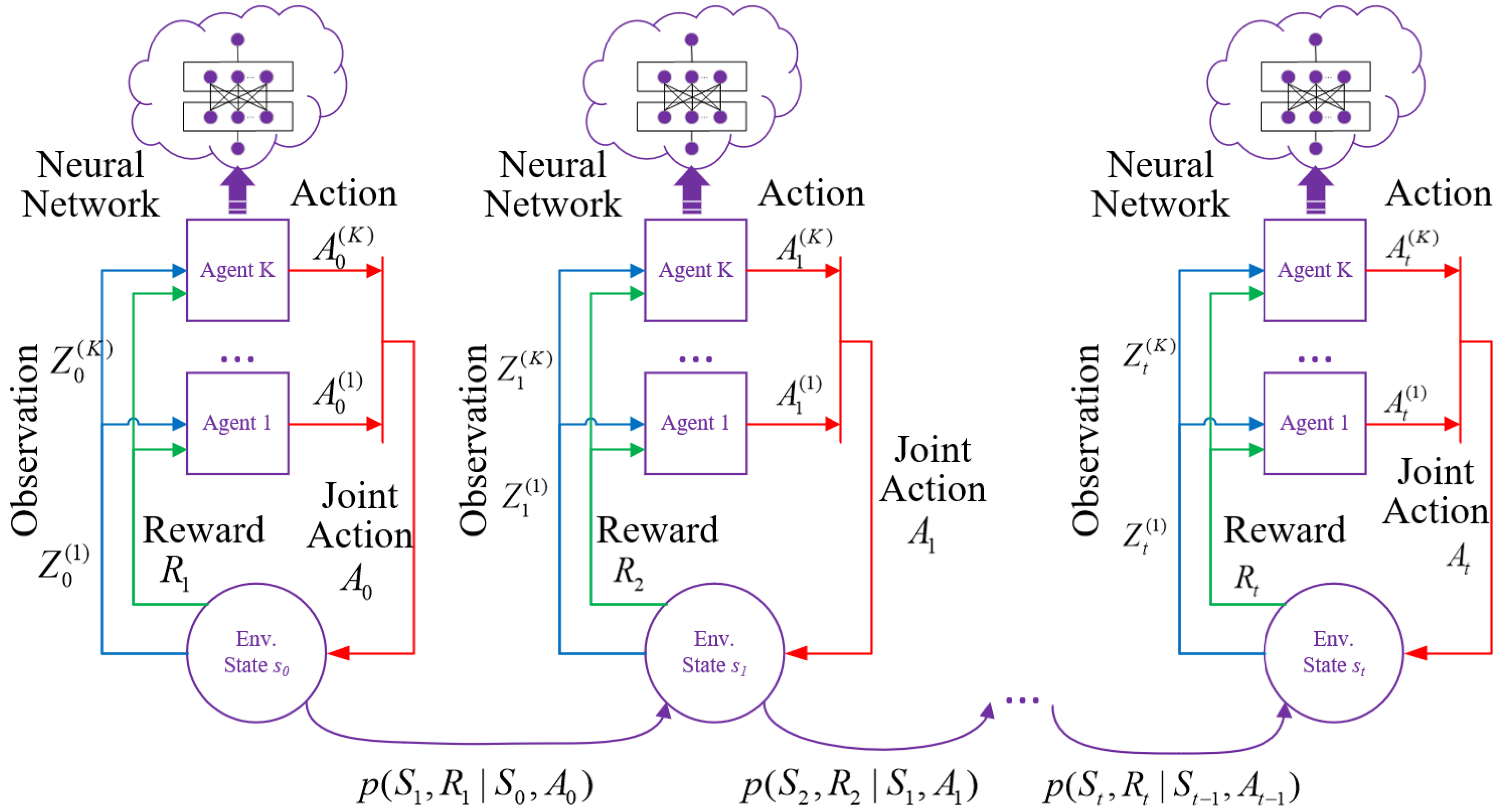


Fig 3. Markov Decision Process

## Deep Q-Network

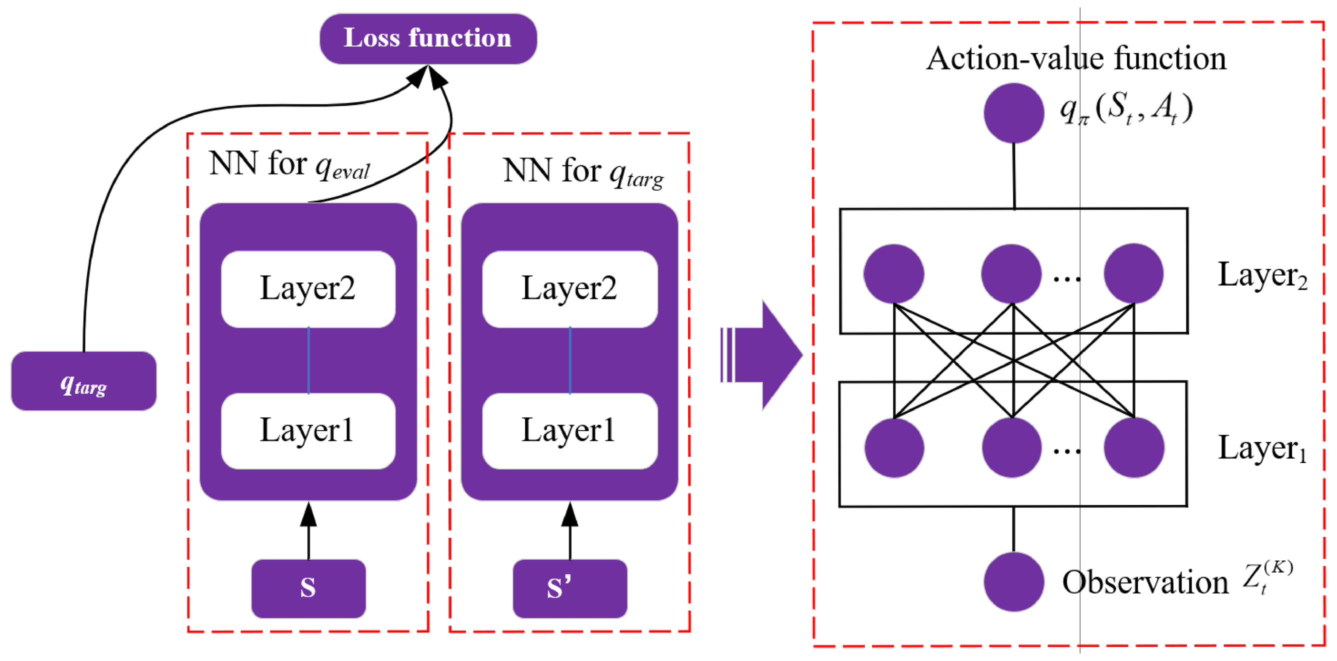


Fig 4. Deep Q-Network

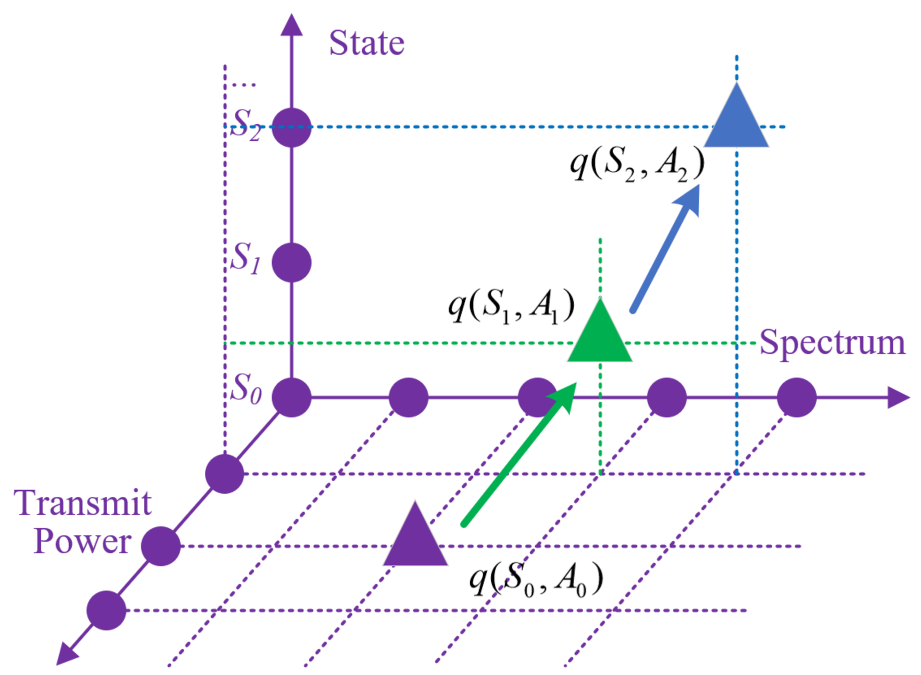


Fig 5. Process of Forming Strategy

## Experimental Results

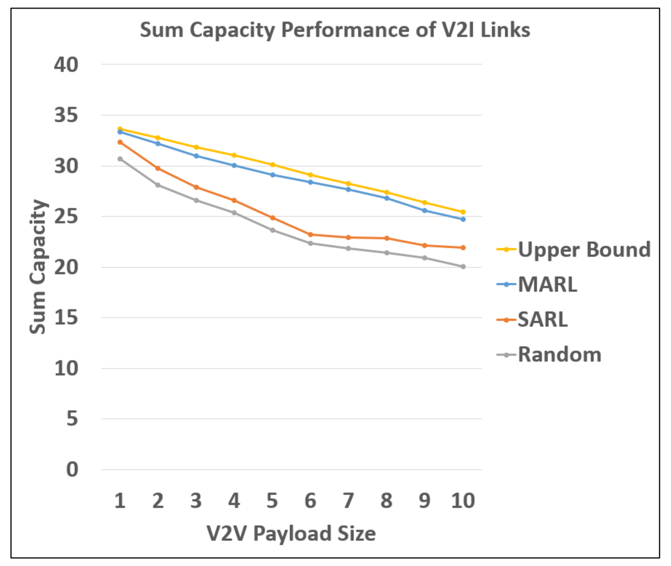


Fig 6. Sum Capacity Performance of V2I Links with Non-Poisson Traffic

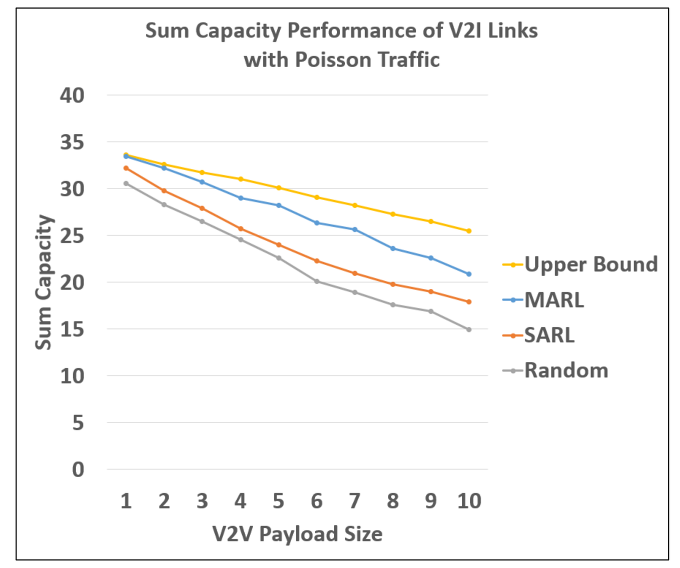


Fig 7. Sum Capacity Performance of V2I Links with Poisson Traffic

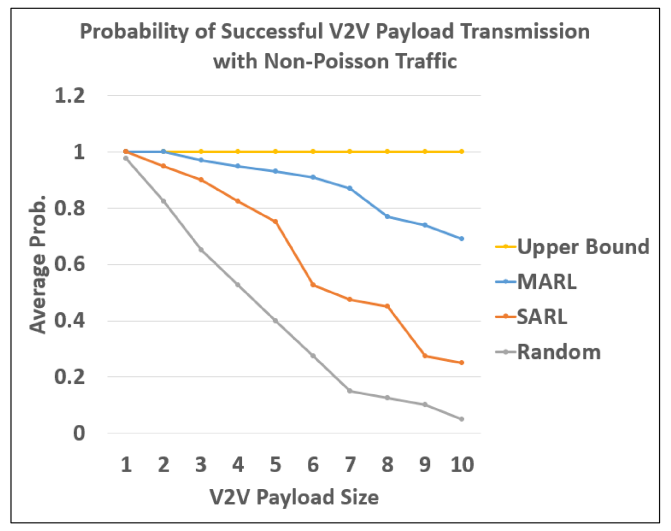


Fig 8. Probability of Successful V2V Payload Transmission with Non-Poisson Traffic

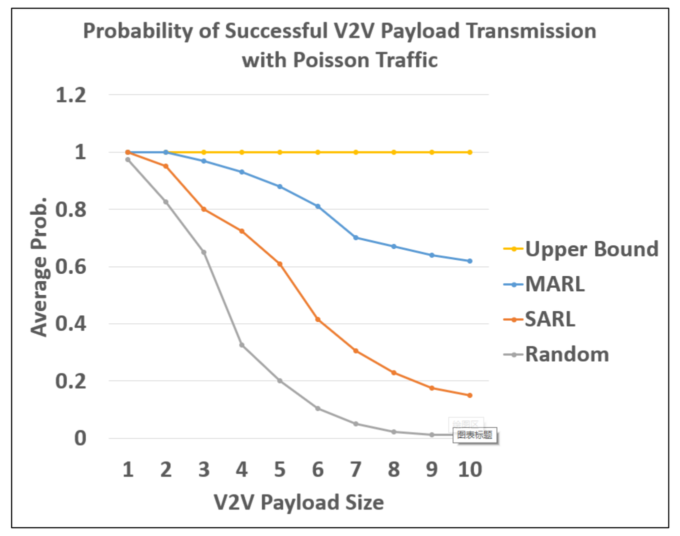


Fig 9. Probability of Successful V2V Payload Transmission with Poisson Traffic

## Conclusion

1. The Markov Decision Progress-based algorithm can be used as a gradually progressive learning strategy for addressing resource allocation problem.
2. The proposed multi-agent resource sharing scheme is effective in encouraging cooperation among V2V links to improve system level performance although decision making is performed locally at each V2V transmitter.
3. Considering Poisson traffic, both sum capacity performance and probability of payload transmission are reduced a bit due to the random arrival of vehicles and time constraints.

## Reference

[1] Le Liang, et al. Spectrum Sharing in Vehicular Networks Based on Multi-Agent Reinforcement Learning, IEEE Journal on Selected Areas in Communication, Oct. 2019

[2] Hao Ye, et al. Deep Reinforcement Learning Based Resource Allocation for V2V Communications, IEEE Transactions on Vehicular Technology, Apr. 2019