



# ESnet

ENERGY SCIENCES NETWORK

# Using AI for Self-driving Networks

**Mariam Kiran**

Lawrence Berkeley National Laboratory

*mkiran@es.net*

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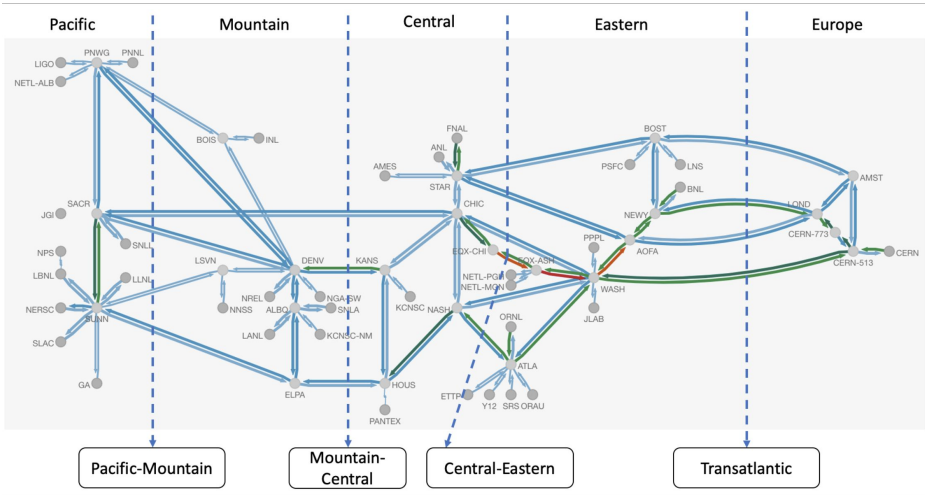


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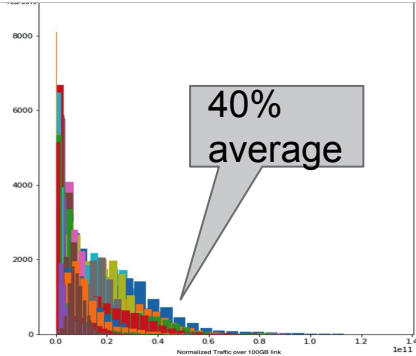
# R&E Networks are the nervous system for Large-scale Science



- Networks are built for resilience
  - Science traffic is highly variable
  - Resources are often underutilized and expensive
- Quality of Network Performance is crucial for Science

Need for **predictability** and **infrastructure adaptability**

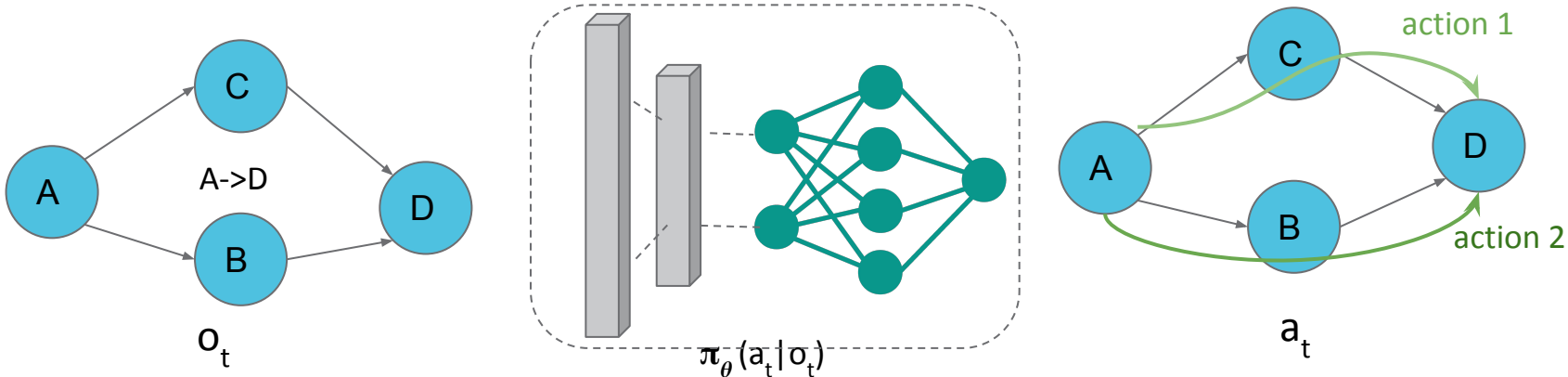
- *Challenge:* how can we optimize network resources (i.e. links) to adapt to variable workloads?



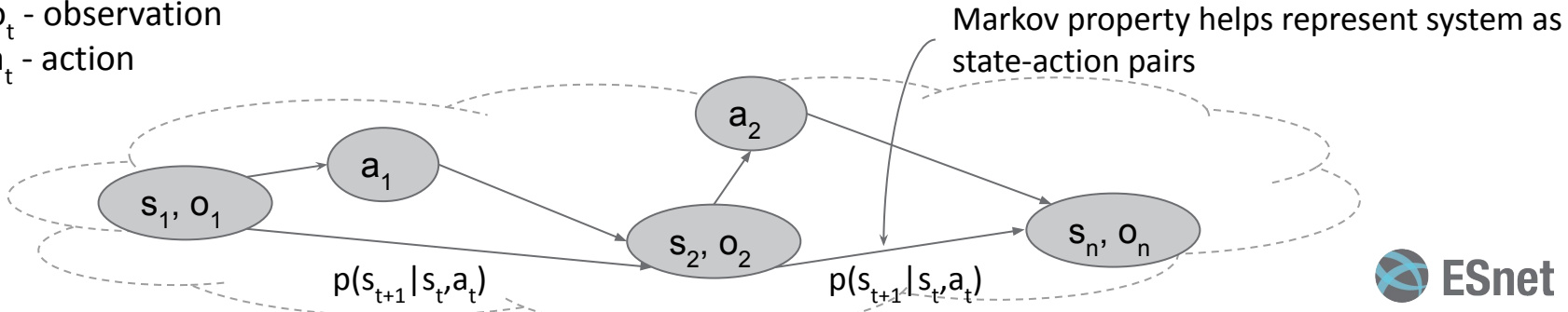
*ESnet Network and its utilization in 2019 over 100GB links*

# Data-driven (active) learning through experience

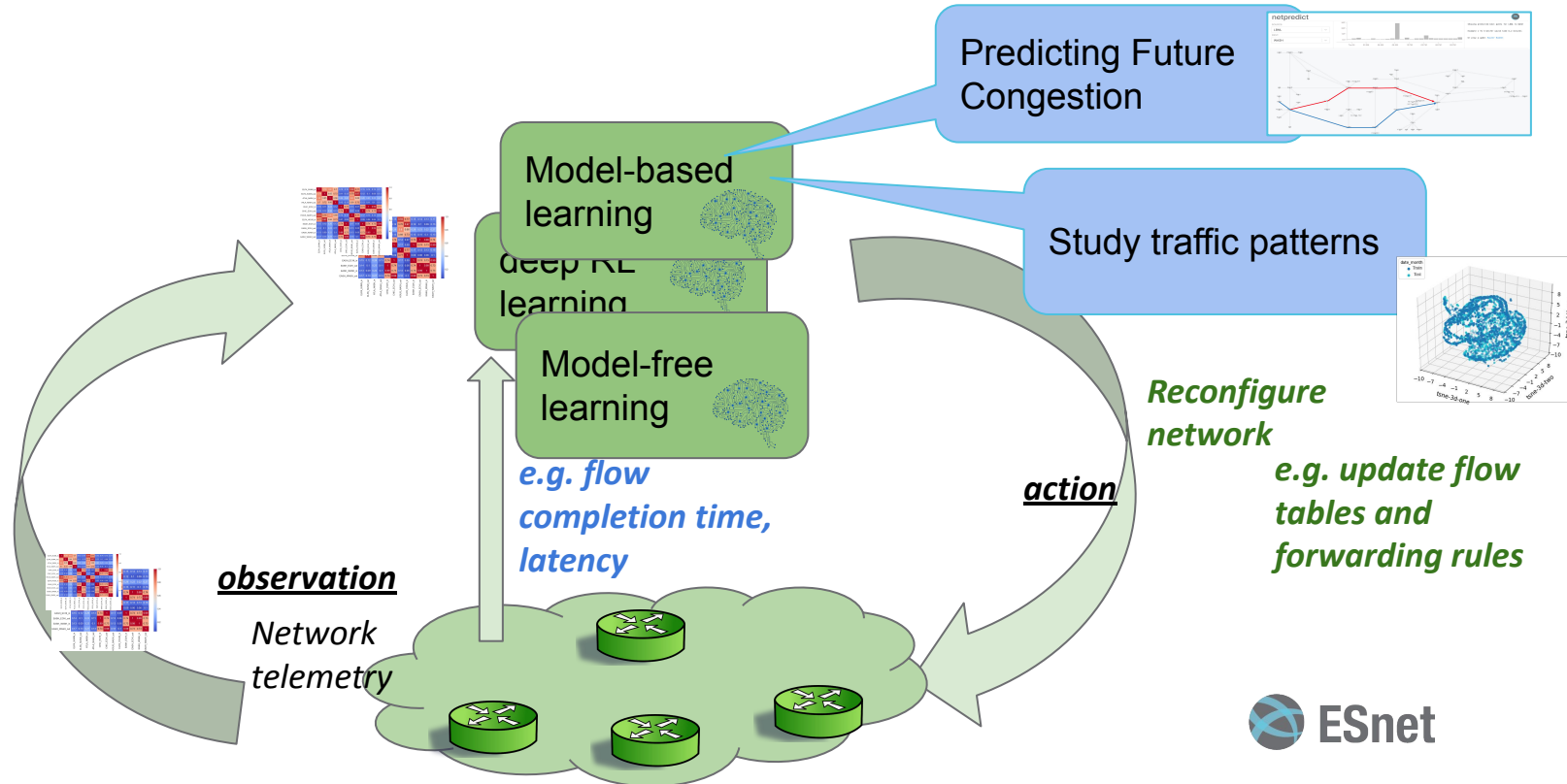
## Deep reinforcement learning (DRL)



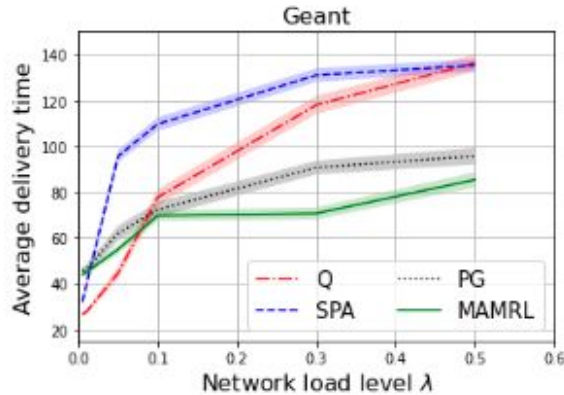
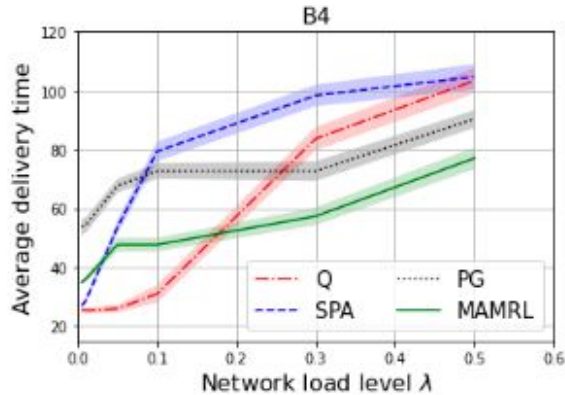
$s_t$  - state  
 $o_t$  - observation  
 $a_t$  - action



# Representing Network as Deep Learning Problem



# Improving packet delivery at high loads



SPA: shortest possible  
Q: Q-learning  
PG: policy-gradient  
MAMRL: multi-agent meta learning

Self-driving networks improves network performance at high loads

- Leverage traffic patterns into DRL learning to cater to different traffic characteristics
- Integrate multiple network controllers to allow connection to diverse devices
- Introduce optimization and online learning to adapt during inference
- Future work to extend to ESnet traffic engineering protocols

# Thankyou for Listening

- Further work on adapting quickly to link failures or network changes
- Exporting the ML models to heterogeneous hardware for network deployment
- Expanding to 5G and quantum networks

Contact: [mkiran@lbl.gov](mailto:mkiran@lbl.gov)

