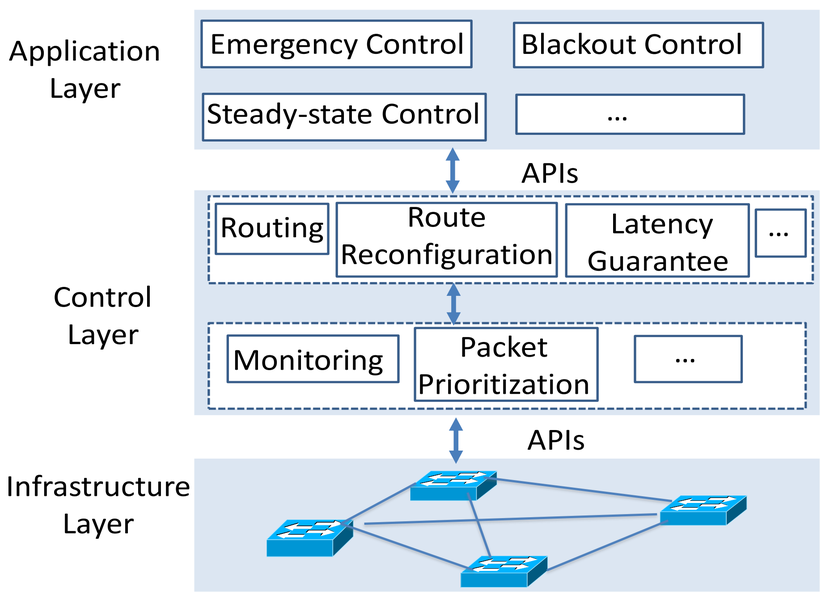
SDN-Enabled Highly Resilient and Efficient Microgrids

Yanyuan Qin, Lingyu Ren, Bing Wang, Peng Zhang, Peter Luh
University of Connecticut

Motivation:

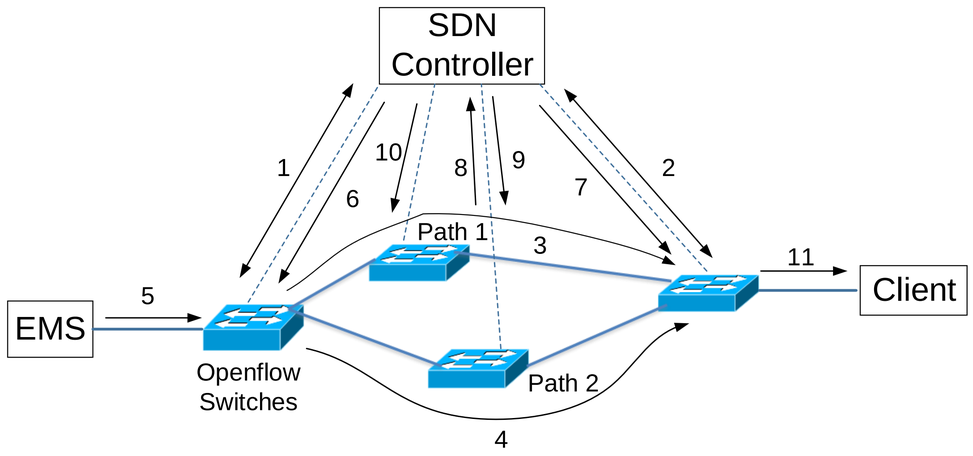
- Microgrid
  - Small-scale, low-voltage power network;
  - Emerging & promising paradigm for improving resilience of electric infrastructure;
  - Enhance power supply quality.
- Communication infrastructure
  - Critical for microgrid with smaller inertia renewable energy sources;
  - Challenges: low latency for time stringent packet (e.g. 4ms), resilience to communication network failures, diverse QoS requirement.
- Software Defined Network
  - Ultra-fast programmable network;
  - Flexible, dynamic network monitor and management;
  - Diverse QoS support.

SDN-based communication architecture

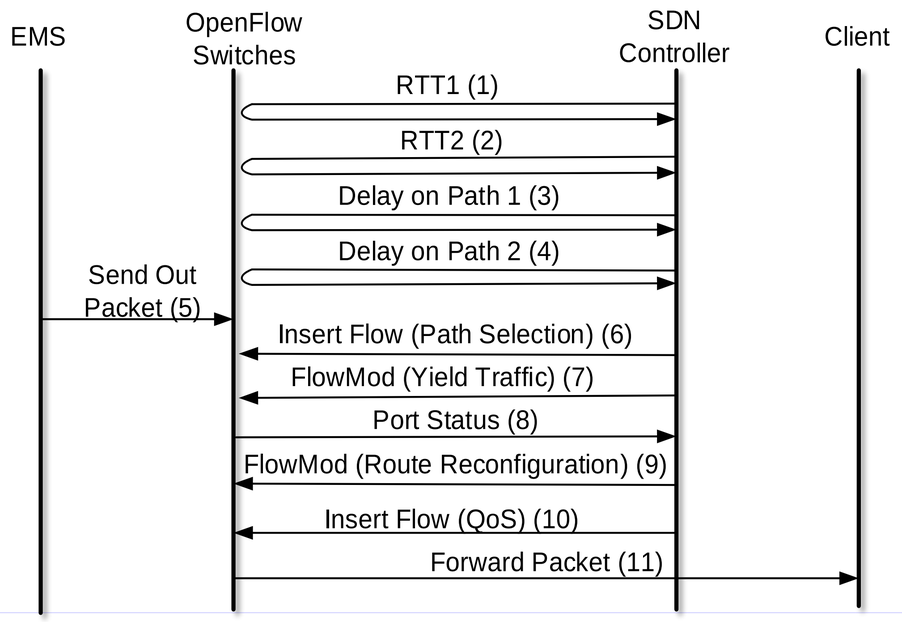


Technical Approach

- SDN Controller actively monitor link delay in real time;
- Dynamically change path based on latency requirement;
- Divert traffic if no path satisfy guaranteed delay;
- Passively monitor port status and dynamically reconfigure route if link fails;
- Packet Prioritization with meter and queue.



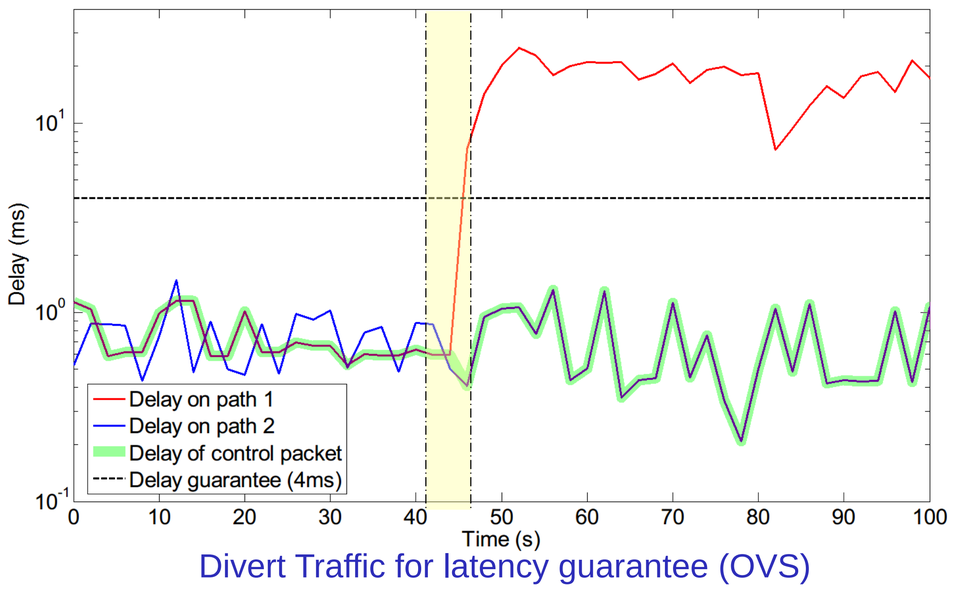
SDN-enabled Microgrid Communication



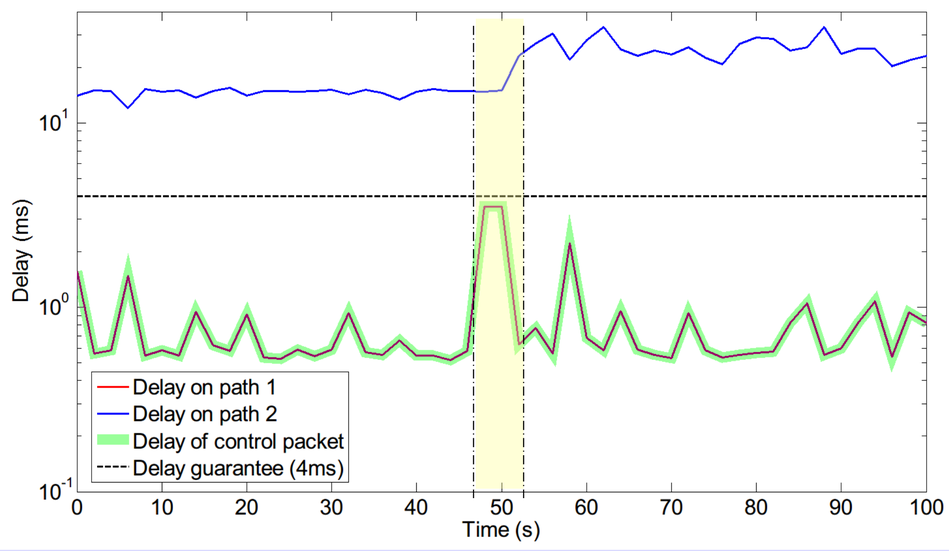
Experimental Results

- GENI infrastructure;
- Open vSwitch and hardware OpenFlow switch.

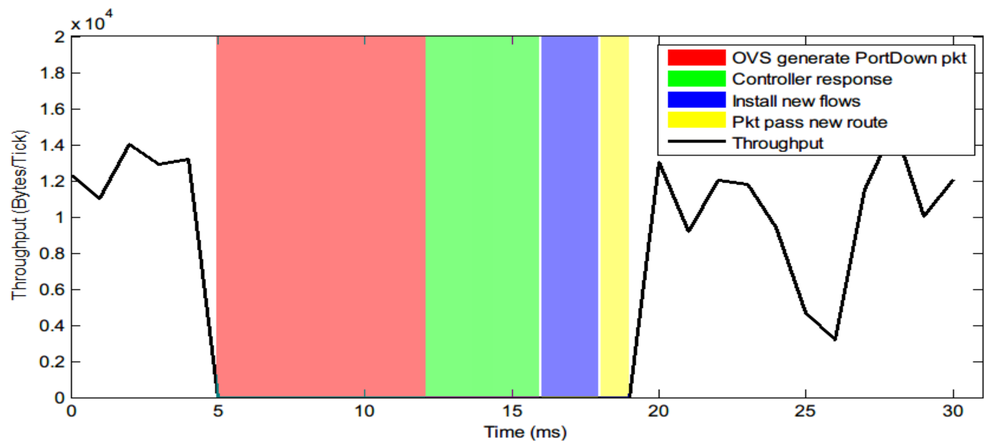
Path Selection for latency guarantee (OVS)



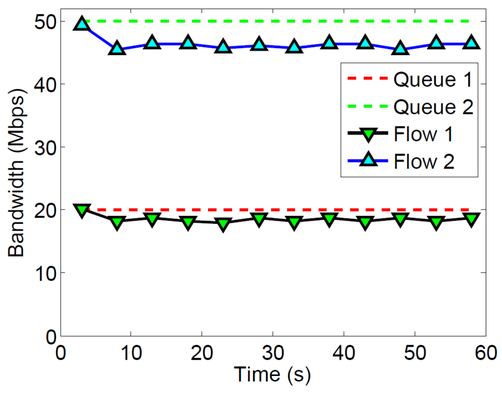
Divert Traffic for latency guarantee (OVS)



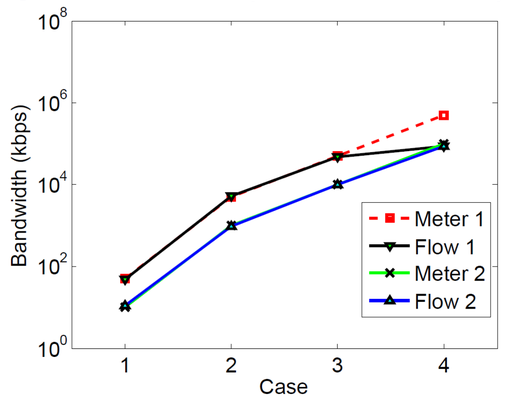
Failover recovery delay (OVS)



QoS with queue (OVS)



QoS with meter (hardware switch)



Conclusion and Future Work

- Innovative SDN-based communication architecture for microgrid;
- Latency-guaranteed communication, failover recovery delay analysis and packet prioritization;
- Evaluation and demonstration using GENI infrastructure.
- Future work:
  - Improve monitoring accuracy, robustness of route reconfiguration;
  - Extension to various microgrid packets.