Development of Fast Control Plane for an Optical and Electrical Hybrid Switch Network

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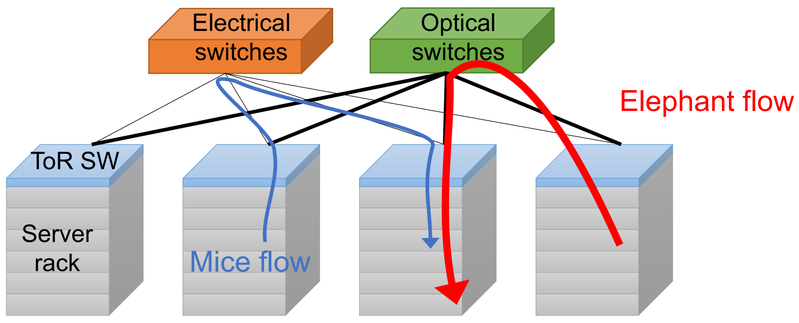
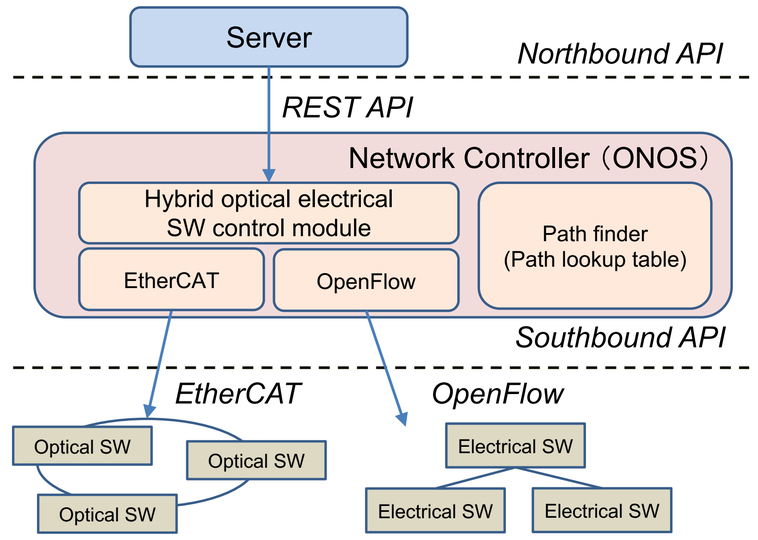
1. Optical/Electrical Hybrid Switch Network

- An optical and electrical hybrid switch network is a fascinating approach to expand network bandwidth and reduce power consumption in data center networks [1].
  - The power consumption of an optical switch is constant regardless of the signal bitrate. However, the switching time is longer.
  - The switching time of our optical switch (under development) is less that 100 μs.
- **Goal**: scale up to more than 1000 racks and fast control of optical switches within 100 μs.



2. ONOS-based Control Plane Architecture

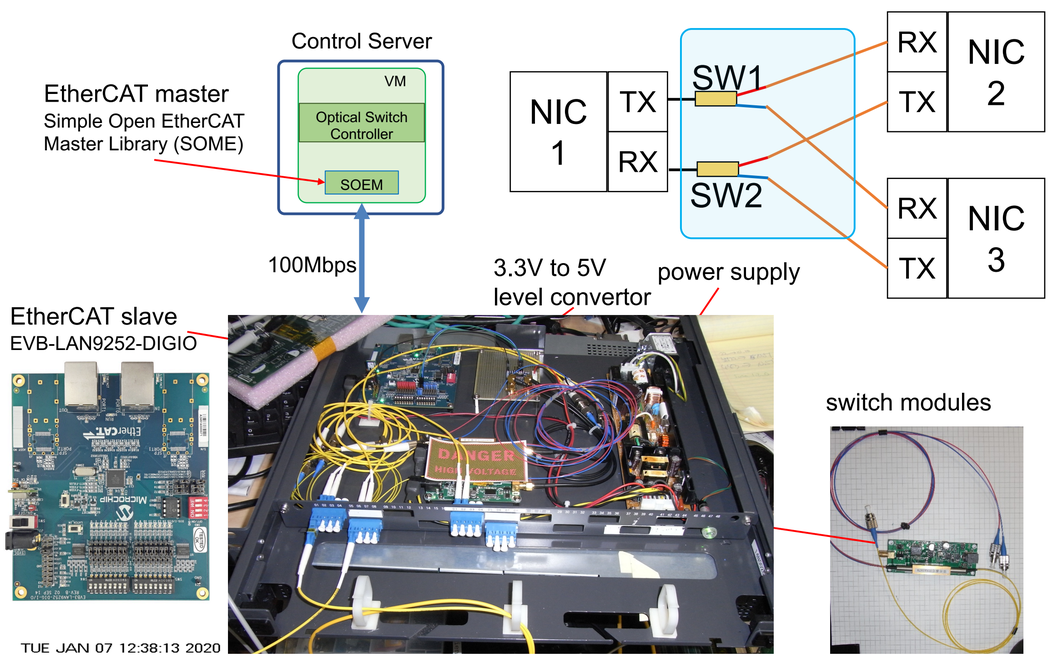
- We have designed a control plane architecture for O/E hybrid switch network based on **Open Network Operating System (ONOS)**.
- As the southbound API, OpenFlow and EtherCAT are used for controlling electrical switches and optical switches, respectively.
- **EtherCAT** (a real-time industrial Ethernet standard) is a key technology in creating such a large-scale and time-constraint control plane network.



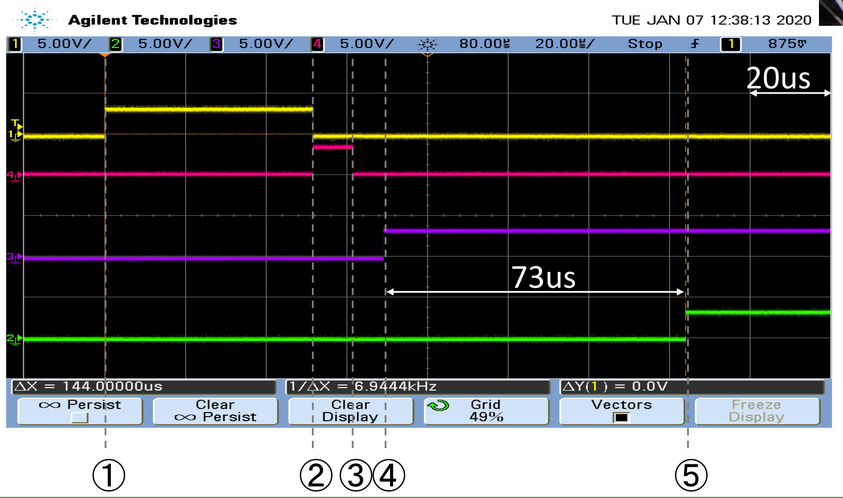
ONOS-based Control Plane

3. Preliminary Evaluation for EtherCAT

- We successfully demonstrated the feasibility of EtherCAT in a proof of concept experiment.
- 144 μs switching time was observed as shown below, which is expected to be reduced by changing the software-based master implementation to hardware-based one.



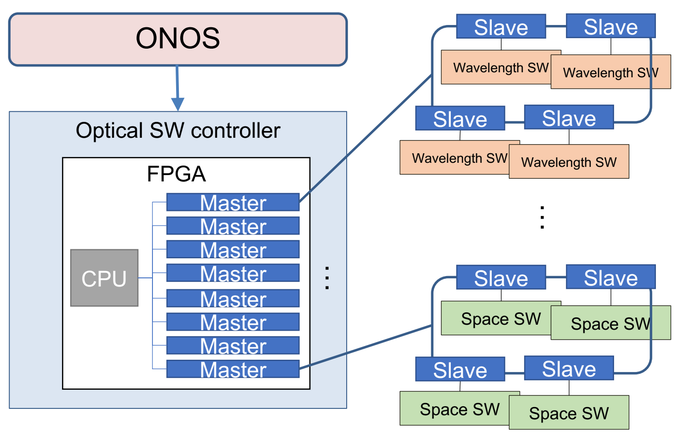
Experimental Setting



A sample timing chart of EtherCAT processing
① t = 0 μs: the master accepts the request, ② t = 52 μs: the master starts to write a bit into shared memory, ③ t = 61 μs: the write request is completed, ④ t = 71 μs: a PDO cycle begins, and ⑤ t = 144 μs: optical switch is configured.

4. Future Work for Further Scaling

- By implementing multiple (e.g., 16) masters in a single FPGA chip, we expect to support 1000 slaves while meeting time constraint of 100 μs.



Fast Optical Switch Controller

	#slaves/ master	Switching time
EtherCAT	60	88 us
EtherCAT G	80	70 us

Acknowledgement
This poster is based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

[1] K. Sato, “Realization and application of large-scale fast optical circuit switch for data center networking,” Journal of Lightwave Technology, vol. 36, no. 7, pp. 1411–1419, Apr. 2018.