

### Motivation:

- Annual IP traffic in data centres forecast to grow 23% per year to 14 ZB by 2021
- Hyperscale data centres will almost double in number to 628 in 2021 compare to 2016 figures.
- The volume of traffic and scale of the environment brings challenges for management of the Data Centre Network (DCN), particularly multi-tenant DCN.
- Many open network management issues to which Software Defined Networking (SDN) can be applied.

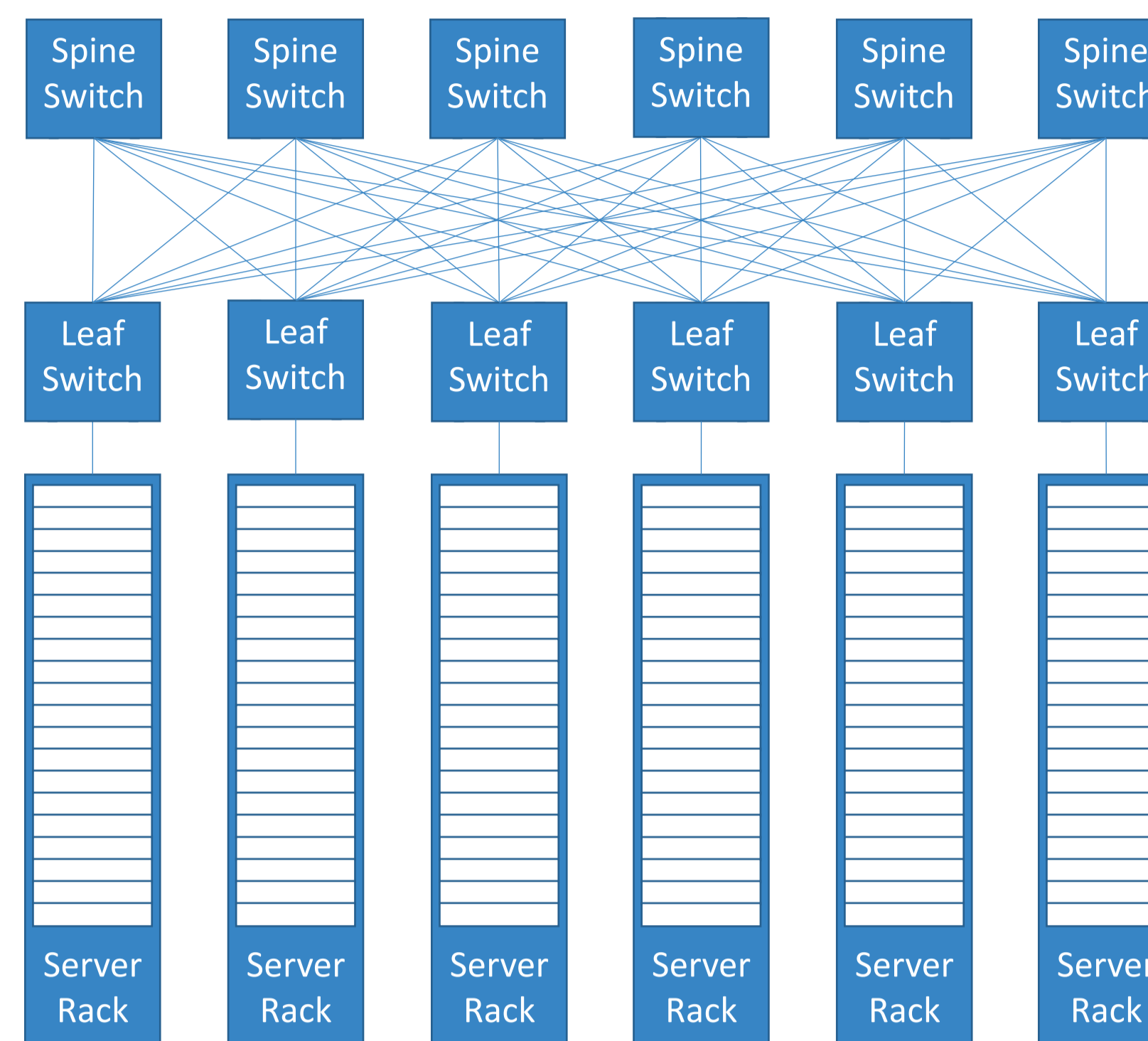


Fig. 1: DCN – Physical Topology

### Hyperscale Data Centre by Numbers:

- 5000+ servers.
- 100's of DCN switches.
- 100,000's of virtual machines / containers.
- Millions of communicating processes.

### Dissemination of Research to Date:

- 'Software-Defined Networking for Data Center Network Management - A Survey and Open Issues', Technical report #UCC-CS-2016-24-06
- 'Improved Data Centre Network Management Through Software-Defined Networking', CERC 2016
- 'Intelligent Management of OpenFlow Rule Installation in Data Center Networks', CoNEXT 2016
- 'Reducing the Latency of OpenFlow Rule Changes in Data Centre Networks', ICIN 2018

### Latest Work for Publication:

- Creating snapshots of DCN network state from OpenFlow message logs.
- Using those snapshots and messages logs to recreate the network with state for any time.

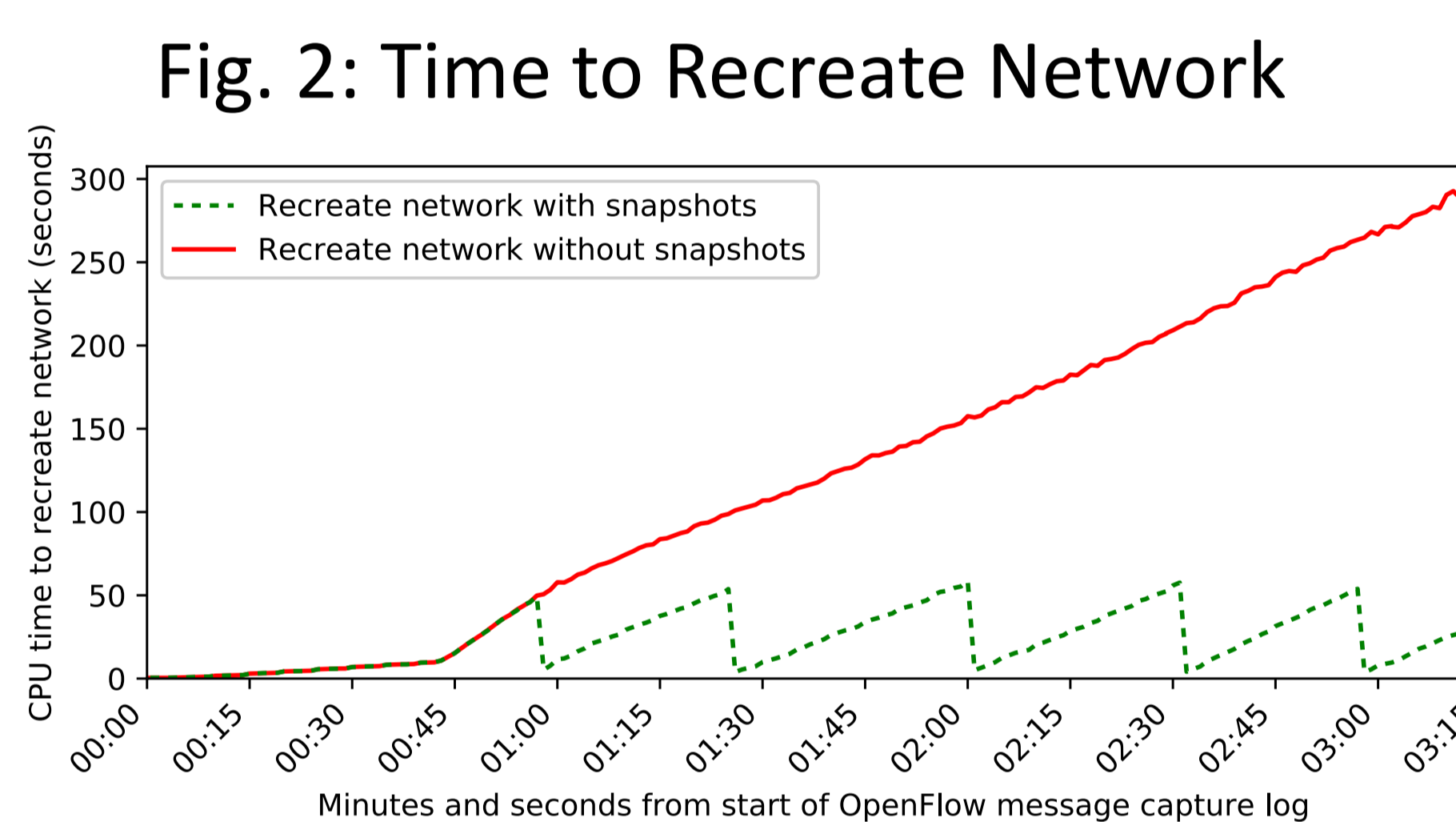


Fig. 2: Time to Recreate Network

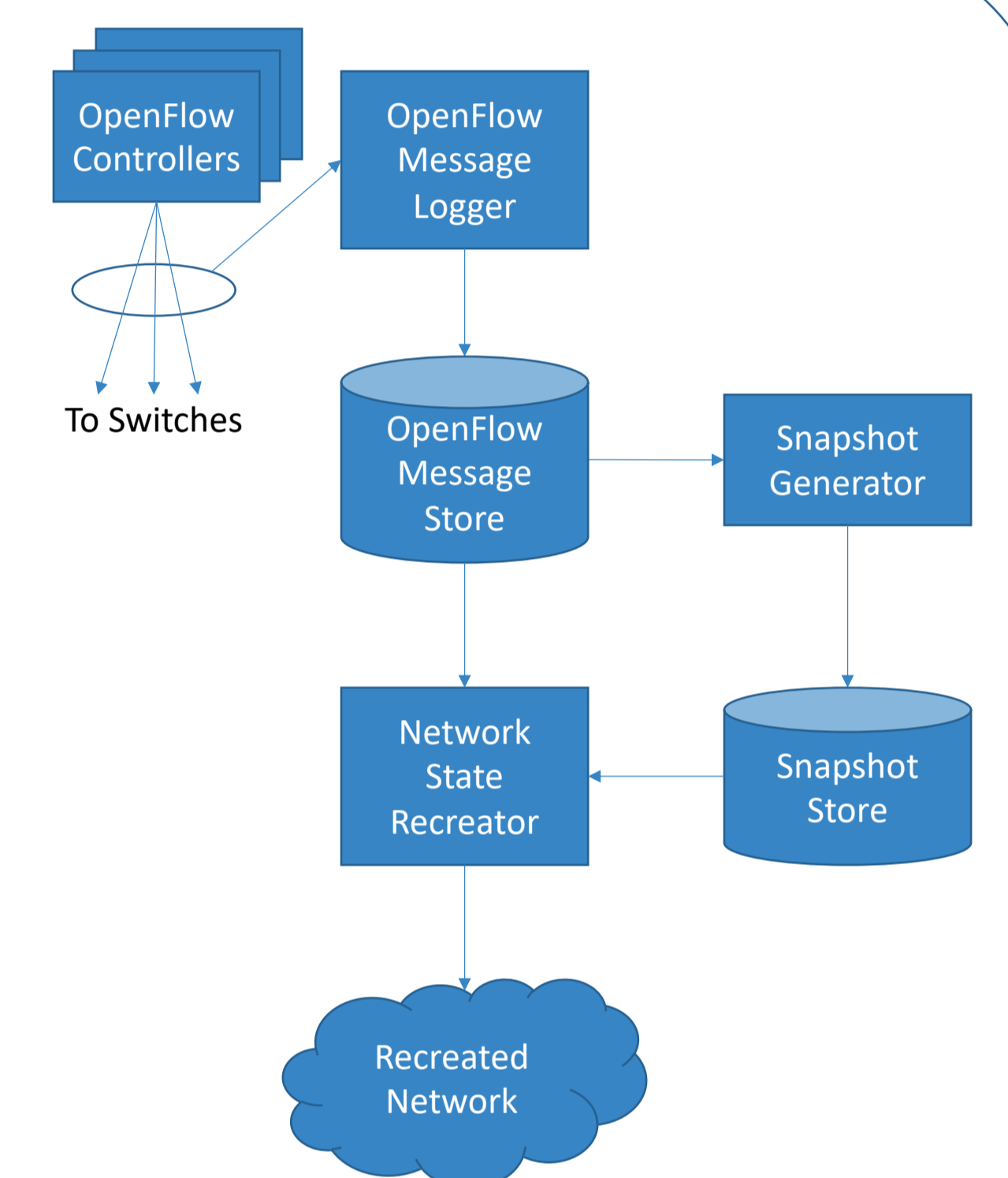


Fig. 3: Architecture Diagram

### Current Research Challenge

- How do we facilitate an operator of an SDN-controlled DCN who wants to query and analyse the past state of the network?
- Querying System Architecture shown in Fig. 4.
- Currently investigating temporal query languages.

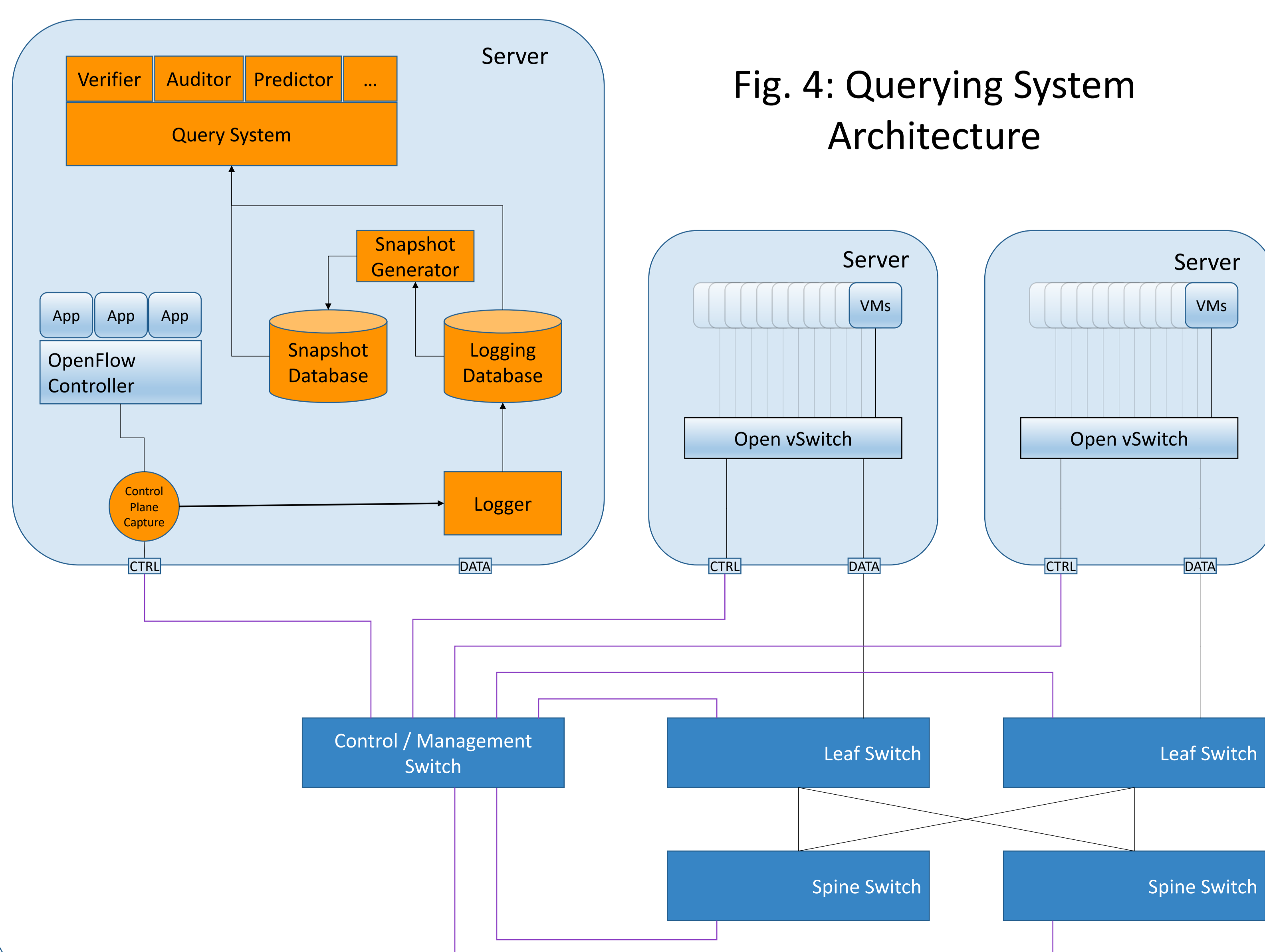


Fig. 4: Querying System Architecture

### Plan for Remainder of PhD

- The work above is complete except for having our paper accepted for publication.
- The current work (described to left) is the basis for the set of tasks to be achieved over the next 6-8 months.
- This will be followed by the thesis write up and submission.
- More work and papers may follow, as we follow some other avenues of research uncovered during our investigations to date.

Item	Tasks	Expected Outputs	Proposed Publications
Logging & Snapshot System	• (All tasks complete)	• (Planned outputs generated)	"Creating Snapshots of OpenFlow data Centre Networks for Offline Querying" – Q2 '19
Query System Development	• Implement Query Engine. • Add sample queries (simple and complex).	• Query Language Primitives. • Query Engine. • Queries.	"What really happened on my DCN last month?" – Q4 '19
Thesis Write Up	• Document the work done over the past 5+ years.	• Completed thesis document.	"Thesis: Improved Management of Software-Defined Networks in Multi-Tenant Data Centres" – Q2 '20

Table 1: Work Plan