Statement: A Database Approach to Composing SDN

Anduo Wang, Temple University

Software-defined networking (SDN) provides an unprecedented opportunity to exercise computing principles in networking practice. Indeed, many salient SDN features — higher-level network abstractions and separated state management — are powered by principles from the fields of programming language, operating systems, and distributed systems. While these principles have resulted in a variety of higher-level SDN abstractions for creating single, monolithic control application, there is little consensus on what are the *"right" abstractions*. The effectiveness in *integrating control applications*, i.e., combining a collection of potentially overlapping and conflicting networking controls into coherent forwarding behavior, is also less evident.

The goal of this proposal is to investigate a computing principle less-visited in SDN: *database principles* as a means to tackle the network abstraction and integration problem. We champion a perspective that SDN control fundamentally revolves around data representation. We propose to take the entire SDN network under the hood of a standard SQL database, relying on SQL for extensible data abstraction, the database integration technique for coordinating and combining the control applications into a coherent forwarding behavior. We envision that such *database-defined network* will yield solutions to multiple problems, including an attractive form of evolvable SDN abstractions and automated coordination between controls applications. Unfortunately, existing applications of database principles is restricted to data representation and/or transactional processing, the unique networking environment also poses challenges not found in the classic database use cases. This "tussle" between networking and database principles presents a barrier to practical database-defined networking.

Intellectual merit. The contribution of this proposal are to break through the networking-database tussle and to solve challenges in abstractions and integration that are necessary for the success of SDN.

1. We propose a database-defined network architecture, addressing two networking requirements not found in classic database applications: (1) the system extensibility requirement to accommodate an enlarging body of control applications; and (2) the performance requirement to cope with very fast data-plane updates under complex control applications.

2. We will adapt the data integration principle to manage dependencies between control applications, addressing the long-standing problem of coordinating multiple applications that collectively drive the behavior of a single network.

3. We propose view synthesis as a means to automatically construct new applications from existing ones, as a step towards a network with applications increasingly built on top of each other in complex ways.

Broader impacts. The results of the proposed database-defined network system will expose to application programmers and network engineers via standard SQL interfaces and database view, constraint, and trigger mechanisms. We believe this is likely to be valuable both technically and as a way to encourage more rapid uptake of SDN. SQL databases have proved over decades to be an effective platform for high-level manipulation of data, and are broadly familiar (compared to domain-specific languages, for example). Moreover, network architects today need to combine heterogeneous data sources — network forwarding rules, data flow and QoS metrics, host intrusion alerts, and so on — to produce a cohesive view of the network and investigate problems; this will be eased by the interoperability of SQL databases.