Software Defined Networking

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In this course, you will learn about software defined networking and how it is changing the way communications networks are managed, maintained, and secured.

Caveat…

- Too many open problems to discuss in a short lecture!
- Will simply recap highlights from some of the course interviews.
- This list also reflects my bias.

Open Problem Areas in SDN

- Northbound API and Applications
  - Wide-area networking, interdomain routing
  - Programming and debugging SDNs
- Control
  - Fault tolerance
  - Security, data-leak prevention
  - Quality of service
  - Combining big data with network management
  - Verification
- Data Plane
  - Moving beyond match/action

New Applications and Services

- We studied the use of SDN in various contexts and for various applications
- **SDN is just a tool. It does not specify the killer application.**
- **Still needed:** What is the compelling application that ISPs and operators want that needs SDN?

Wide-Area Networking

- Interdomain routing is brittle
  - Mechanisms are indirect
  - Policies only based on destination prefix
  - Can only influence direct neighbor
- We explored a way of introducing disruptive change at an IXP (SDX).
- Future: New protocols, business models, applications

Programming and Debugging

- Programming applications for SDNs is getting easier with new high-level languages, but it is still difficult.
- Coupling and composing heterogeneous control programs is not always possible.
- Debugging is very challenging.
- **Future:** Heterogeneous components and control, debugging.

Fault Tolerance

- Need for a general, fast recovery mechanism
- When data-plane elements fail, controller must recompute alternate paths
- No notion of IP fast re-route for SDN
- Current fault tolerance approaches are typically application-specific

Security

- Current Internet architecture has no accountability built in
- Security properties are extremely difficult to verify and enforce
- Data leaks are incredibly common
- **Future:** Can SDN control traffic flows according to formal security policy?

Quality of Service

- Network-wide visibility and control may assist in providing applications quality of service
  - Applications provide hints to network about requirements
  - Network offers visibility to applications that can make better decisions

FlowQoS: QoS for the Rest of Us, M. Said Seddiki, Muhammad Shahbaz, Sean Donovan, Sarthak Grover, Miseon Park, Nick Feamster and Ye-Qiong Song, ACM SIGCOMM, Chicago, IL, USA, August 2014

SDN Meets Big Data

- We have seen how SDN makes certain network management tasks easier.
- No existing technology takes advantage of the huge amount of data about the network
  - Regular traffic patterns, prediction, etc.
- **Needed:** Means of mining configuration, traffic demands, etc. to enable intelligent management.

Verification

- Important work on pieces of the puzzle
  - Control-plane (Kinetic) and data-plane (HSA, …)
- Many important problems remain
  - Coupling data and control plane verification
  - Composing verification
  - Applying verification to security properties.

Orchestration & Beyond Match/Action

- SDN is more than just match/action. It is logically centralized control of multiple network devices.
- We have seen several extensions
  - RMT, Middleboxes, Programmable substrates
- **Still needed:** Unifying control framework for compilation/orchestration.

Summary

- Many open problems in SDN in many areas
  - **Northbound API:** Programming, New applications
  - **Control plane:** Orchestration
  - **Data plane:** Moving beyond match/action

- With this course as a starting point, you are now equipped to solve the next set of SDN problems!