



Software Defined Networking

Dr. Nick Feamster
Professor

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

This Module: SDN In the Wild

- ◎ Three Lessons
 - Data Centers
 - **Wide-Area Backbone Networks**
 - SDX: A Software-Defined Internet Exchange
 - **B4: Google's Wide-Area Backbone Network**
 - Home Networks
- ◎ Programming Assignment
- ◎ Quiz

Case Study: Google B4 Network



- Google operates two large backbone networks
 - Internet-facing backbone (user traffic)
 - Datacenter backbone (internal traffic)
- Managing large backbones is hard
- OpenFlow has helped Google improve backbone performance and reduce backbone complexity and cost

WAN-Intensive Applications

- YouTube
- Web search
- Google+
- Photos, Hangouts
- Maps
- AppEngine
- Android and Chrome Updates

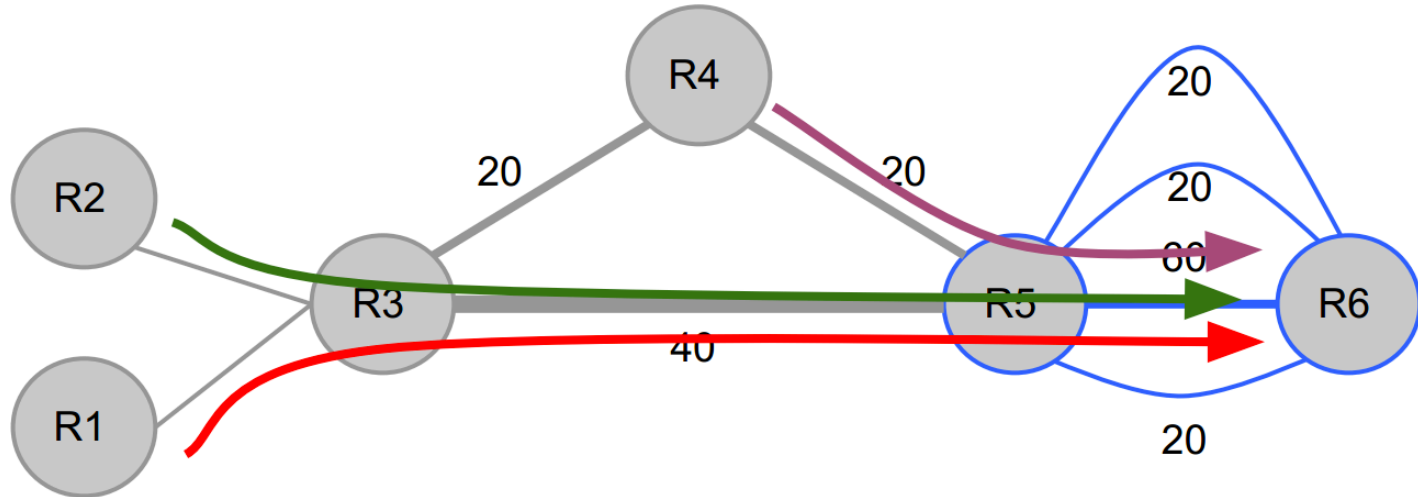
Problem: Cost/bit does not necessarily decrease with the size of the network. (Complexity of pairwise interactions, manual management and config, non-standard vendor APIs)

Solution: WAN Fabrics

- ◎ **Goal:** Manage the WAN as a fabric, not as a collection of individual boxes
- ◎ Current equipment and protocols make this difficult: protocols are box-centric, with little support for monitoring, low-latency routing, fast failover

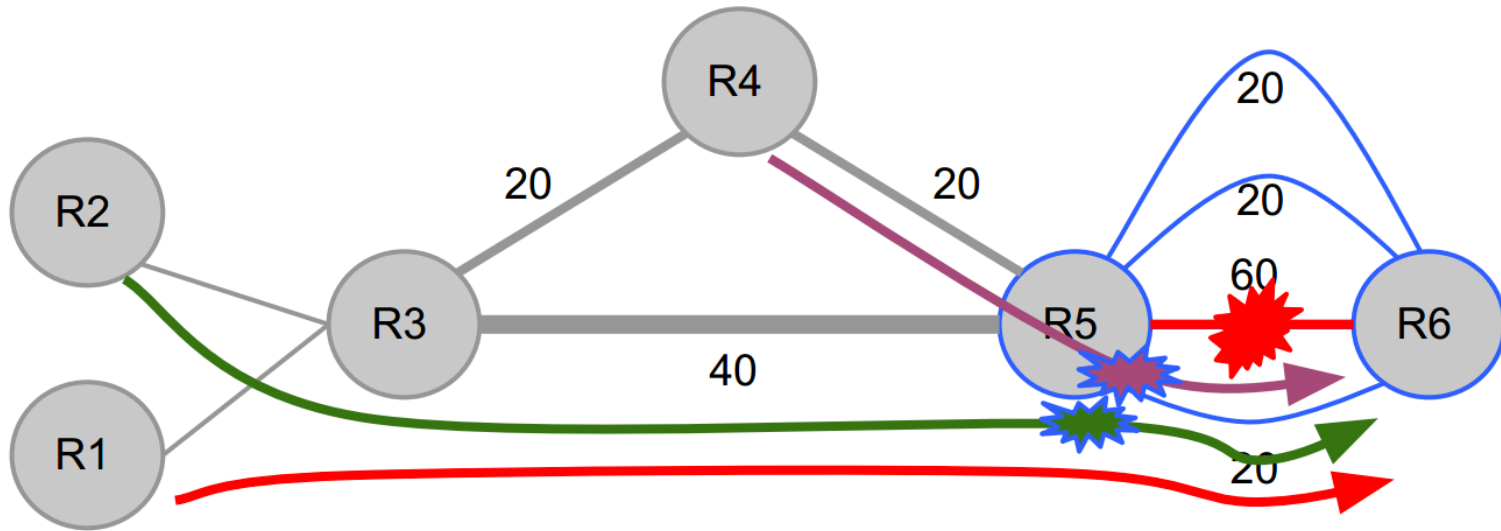
Example: Convergence After Failure

Flows: R1->R6: 20; R2->R6: 20; R4->R6: 20



Software Defined Networking

Example: Convergence After Failure



Advantages of Centralized TE

- Better network utilization with global picture
- Converges faster to target optimum on failure
- Allows more control and specifying intent
 - Deterministic behavior simplifies planning vs. overprovisioning for worst case variability
- Can mirror production event streams for testing
 - Supports innovation and robust SW development
- Controller uses modern server hardware
 - 50x (!) better performance

SDN Also Helps Testing

- ⦿ Decentralized network requires full-scale replica of a testbed to test new TE features
- ⦿ Centralized control can use real production network as input to research new ideas, test new features
 - Control servers run real binaries
 - Switches are virtualized

Summary: Why Software Defined WAN

- ◎ Separate hardware from software
 - Choose hardware based on necessary features
 - Choose software based on protocol requirements
- ◎ Logically centralized network control for TE
 - Easier management
 - Easier testing
- ◎ Separate monitoring, management, and operation from individual boxes