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Software Defined Networking



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

Module 7.3: 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

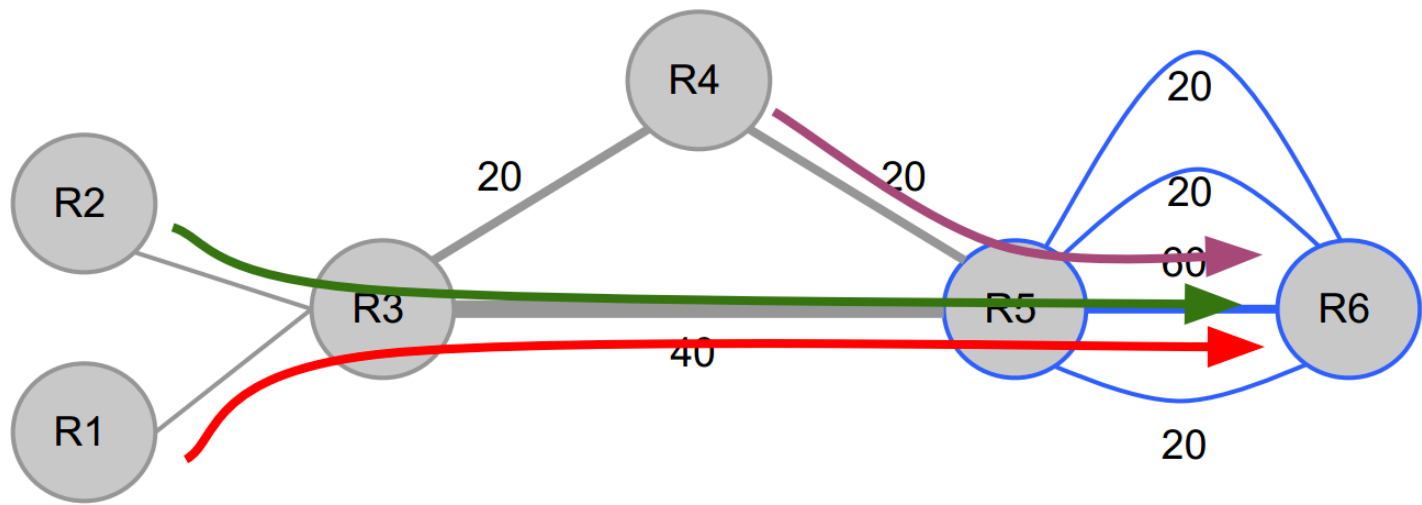
Problem: Cost/bit does not necessarily decrease with the size of the network. (Complexity of pairwise interactions, manual management and config, non-standard vendor APIs)

Solution: WAN Fabrics

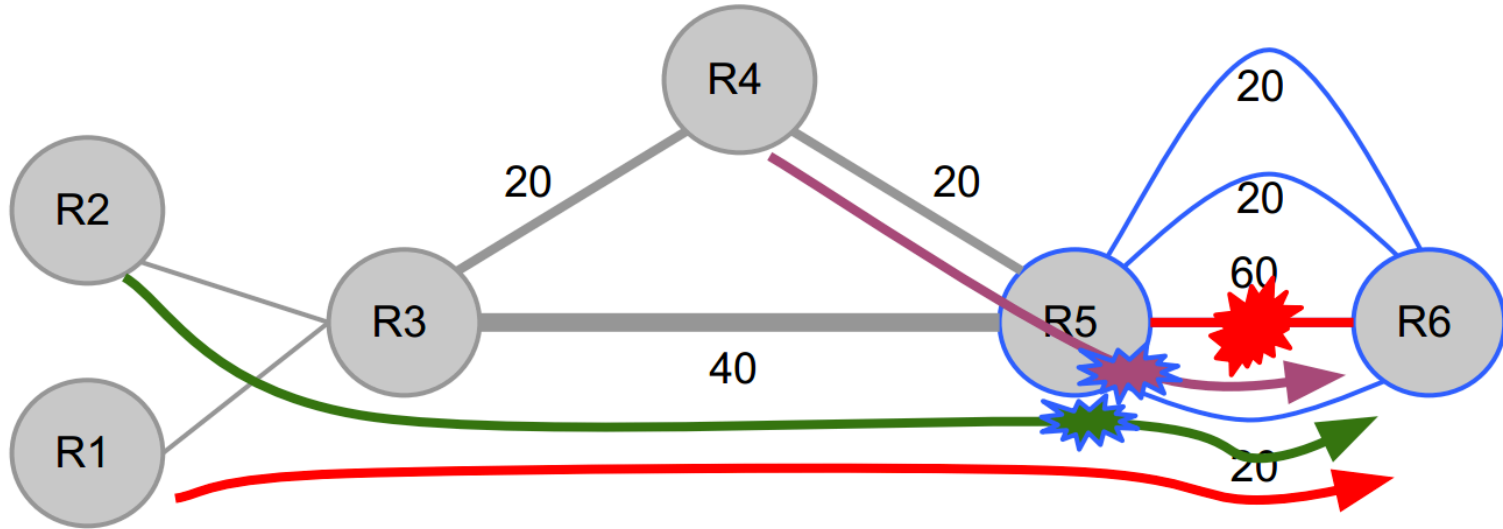
- ◎ **Goal:** Manage the WAN as a fabric, not as a collection of individual boxes
- ◎ Current equipment and protocols make this difficult: protocols are box-centric, with little support for monitoring, low-latency routing, fast failover

Example: Convergence After Failure

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



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