Software-driven wide area network

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Inter-DC WAN: A critical, expensive resource
But it is highly inefficient
One cause of inefficiency: Lack of coordination

Peak-to-mean ratio = 2.17

Background traffic
Non-background traffic

Peak before adapting
>50% peak reduction

Peak after adapting
Another cause of inefficiency: Local, greedy resource allocation

Local, greedy allocation

Globally optimal allocation
SWAN: Software-drive WAN

Goals:
- Highly efficient WAN
- Support flexible sharing policies
  - Strict priority classes
  - Max-min fairness within a class

Key design elements:
- Coordinate the sending rate of services
- Centralized resource allocation
SDN primer

Networks today
- Beefy routers
- Control plane: distributed, on-board
- Data plane: indirect configuration

SDNs
- Streamlined switches
- Control plane: centralized, off-board
- Data plane: direct configuration
SWAN overview

- SWAN controller
  - Traffic demand
  - Topology, traffic
  - Network config.
  - BW allocation

- Service broker
- Network agent
- Rate limiting

- Service hosts
- WAN
Key design challenges

- Scalably computing BW allocations and network config
- Avoiding congestion during network updates
- Working with limited switch memory
- Resilience to failures and bugs

[Achieving high utilization with software-driven WAN, SIGCOMM 2013]
Congestion during network updates
Congestion-free network updates
Computing congestion-free update plans

Leave scratch capacity $s$ on each link

- Ensures a plan with at most $\left\lceil \frac{1}{s} \right\rceil - 1$ steps

Find a plan with minimal number of steps using an LP
- Search for a feasible plan with 1, 2, ..., max steps

Use scratch capacity for background traffic
Demo
Demo topology

CH (Chicago)

CO (Columbia, WA)

BN (Boydton, VA)

SN (San Antonio, TX)
Demo traffic

Interactive
(High priority)

Elastic
(Mid priority)

Background
(Low priority)
SWAN comes close to optimal

Throughput (relative to optimal)

- SWAN
- SWAN w/o rate control
- MPLS TE
Summary

SWAN yields a highly efficient and flexible WAN
- Coordinates transmissions of services
- Allocates resources centrally
- Manages transitions between allocations

High efficiency is key to cost-effective cloud services
- Many avenues for impactful research
- Opportunity to be “clean slate”