Use cases of SDN

Applications

Network Virtualization

- The original idea behind using SDN to create virtual networks is widely credited to the team at Nicira.
- Nicira was founded by three of the acknowledged pioneers of SDN: Martin Casado, Scott Shenker, and Nick McKeown.
- While Nicira was founded to make commercial use of SDN , it was Network Virtualization that became the industry's first successful application of SDN.

Network Virtualization (Cont.)

- The key insight was that modern clouds required networks that could be programmatically created, managed, and torn down, without a sysadmin having to manually configure, say, VLAN tags on some number of network switches.
- By separating the control plane from the data plane, and logically centralizing the control plane, it became possible to expose a single API entry point for the creation, modification, and deletion of virtual networks.

Network Virtualization (Cont.)

- This meant that the same automation systems that were being used to provision compute and storage capacity in a cloud (such as OpenStack at the time) could now programmatically provision a virtual network with appropriate policies to interconnect those other resources.
- Because network virtualization set out to deliver a full set of network services in a programmatic way, its impact went beyond the simplification and automation of network provisioning.

An Example

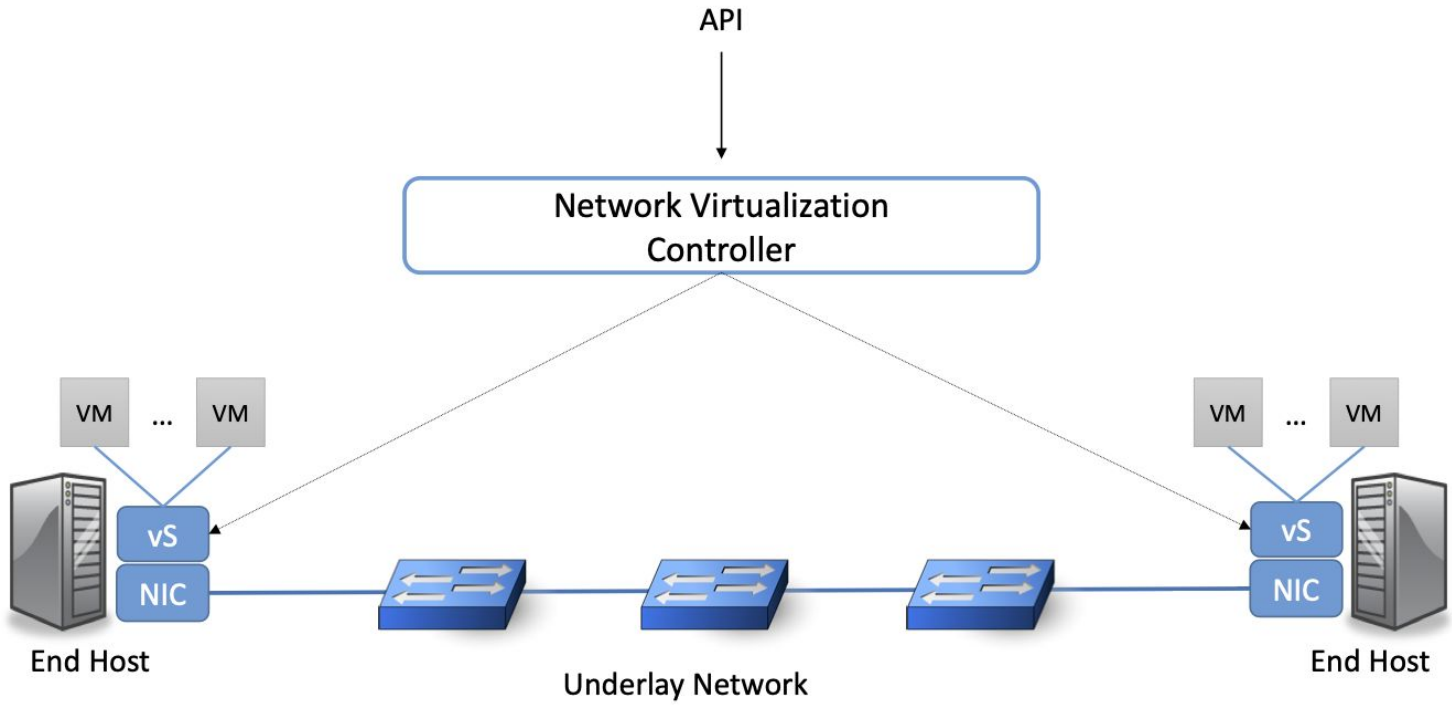

Figure 9. An example network virtualization system

Network Virtualization (Cont.)

- The Network Virtualization Controller is an SDN controller that exposes a northbound API by which networks can be created, monitored and modified. It connects to virtual switches running on hosts–in this case, hypervisors supporting virtual machines.
- Virtual networks are created by programming the virtual switches to forward packets, with appropriate encapsulation, from host to host across the underlay network.

Switching Fabrics for Clouds

- The predominant use case for pure play SDN is within cloud datacenters, where for reasons of both lowering costs and improving feature velocity, cloud providers have moved away from proprietary switches (i.e., those traditionally sold by network vendors), in favor of bare-metal switches built using merchant silicon switching chips.
- These cloud providers then control the *switching fabric* that interconnects their servers entirely in software.

Switching Fabrics for Clouds (Cont.)

- A datacenter switching fabric is a network often designed according to a *leaf-spine* topology.
- Each rack has a *Top-of-Rack (ToR)* switch that interconnects the servers in that rack; these are referred to as the *leaf* switches of the fabric.
- Each leaf switch then connects to a subset of available *spine* switches, with two requirements: (1) that there be multiple paths between any pair of racks, and (2) that each rack-to-rack path is two-hops (i.e., via a single intermediate spine switch).

An Example

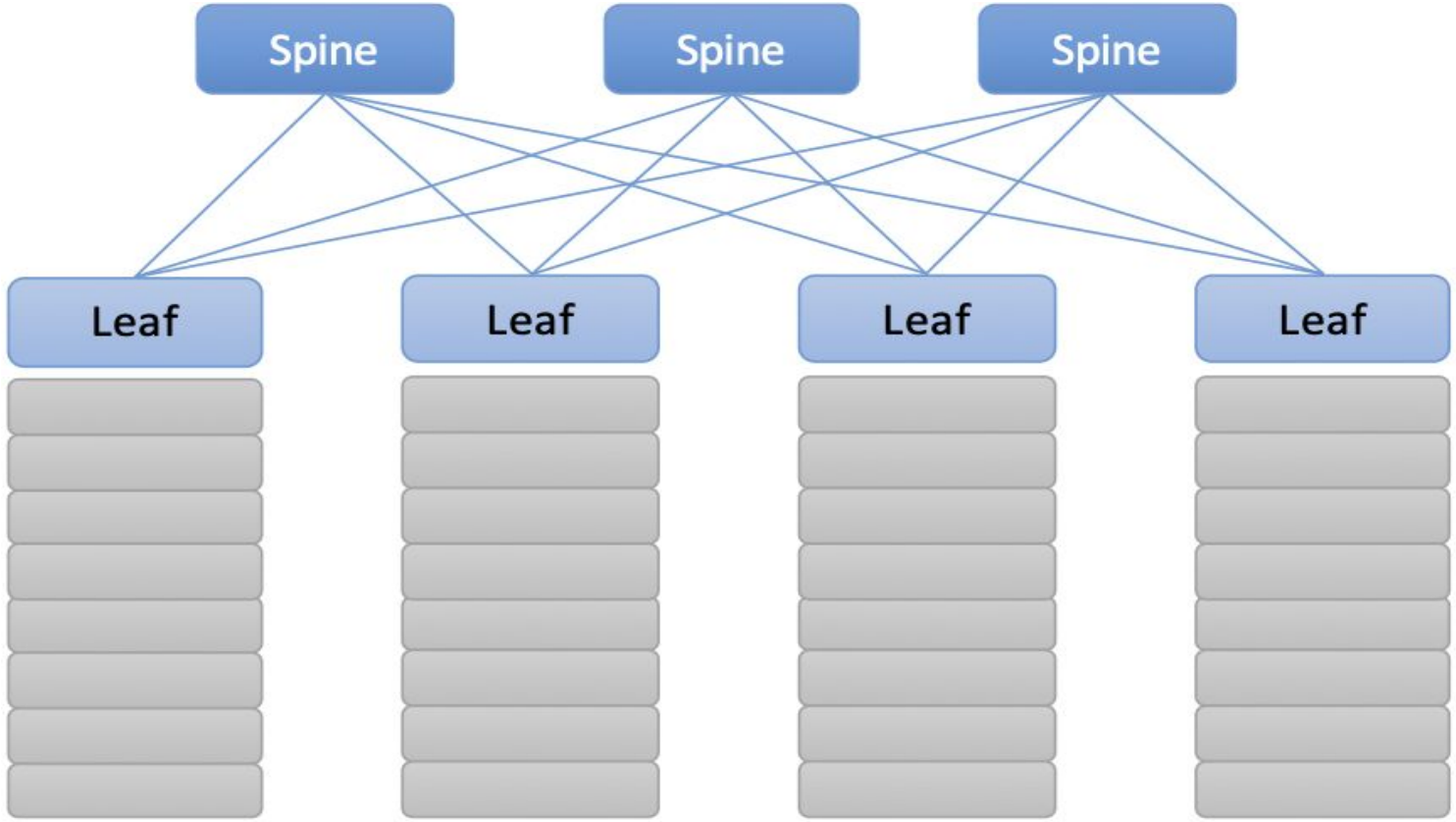

Figure 10. Example of a leaf-spine switching fabric common to cloud datacenters and other clusters, such as on-premises edge clouds.

Traffic Engineering for WANs

- Another cloud-inspired use case is traffic engineering applied to the wide-area links between datacenters.
- For example, Google has publicly described their private backbone, called B4, which is built entirely using bare-metal switches and SDN.
- Similarly, Microsoft has described an approach to interconnecting their data centers called SWAN.
- A central component of both B4 and SWAN is a *Traffic Engineering (TE)* control program that provisions the network according to the needs of various classes of applications.

An Example

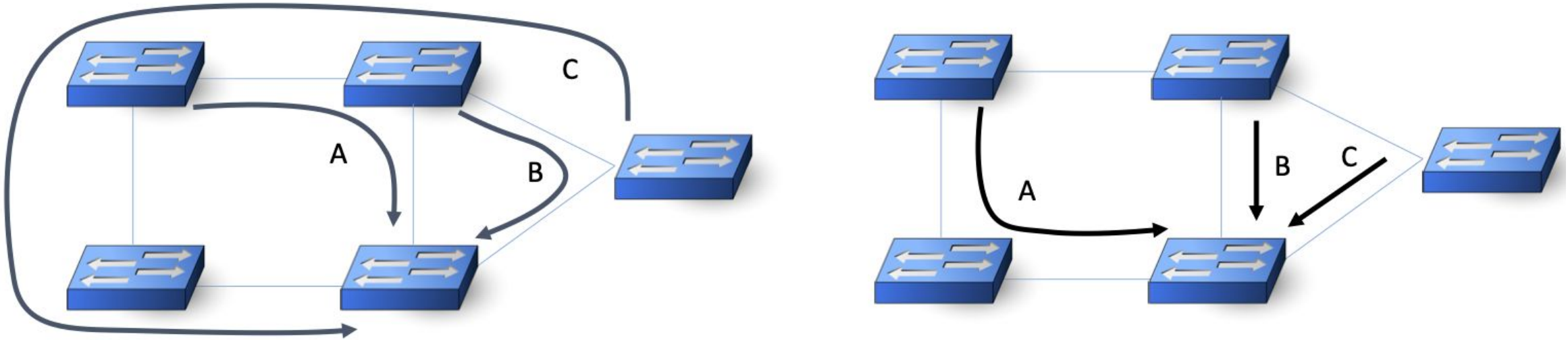

Figure 11. Example of non-optimal traffic engineering (left) and optimal placement (right).

Software-Defined WANs

- Another use-case for SDN that has taken off for enterprise users is *Software-Defined Wide-Area Networks (SD-WAN)*.
- For most of the 21st century the most common technical approach to building such networks has been MPLS, using a technique known as MPLS-BGP VPNs (virtual private networks).
- The rapid rise of SD-WAN as an alternative to MPLS is another example of the power of centralized control.

An Example

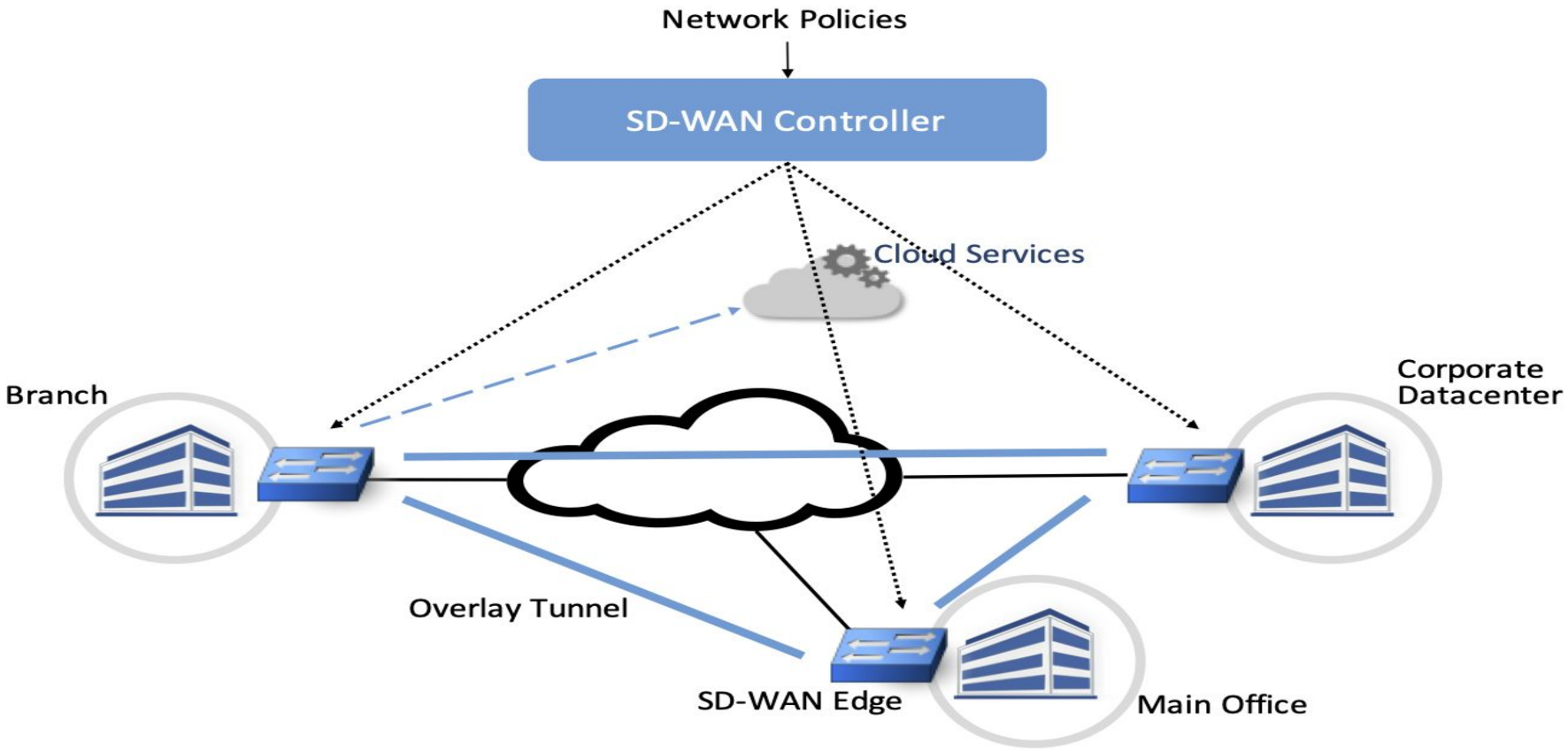

Figure 12. An SD-WAN controller receives policies centrally and pushes them out to edge switches at various sites. The switches build an overlay of tunnels over the Internet or other physical networks, and implement policies including allowing direct access to cloud services.