CS 456
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# Chapter 5.5 The SDN Control Plane

## 5.5.1 Software Defined Networking (SDN)

- The Internet network layer has historically been implemented via a distributed, per-router approach. A router contains switching hardware and runs implementations of Internet standard protocols (such as *IP, RIP, IS-IS, OSPF, BGP...*) in the router OS. There are different sections for different network layer functions (such as *firewall, load balancer, NAT boxes...*). In around 2005, there was interest in rethinking the network control plane.
- Recall that in a **per-router control plane**, individual routing algorithm components in every router interact with each other in the control plane to compute forwarding tables.
- Recall that in a **logically centralized control plane**, a distinct controller interacts with local control agents in routers to compute forwarding tables, and that the controller is usually remotely located. This is how SDN operates.
- A logically centralized control plane:
  - Provides easier network management. Router misconfigurations are avoided and there is greater flexibility of traffic flows.
  - Table-based forwarding (OpenFlow) allows "programming" routers. **Centralized programming**, which computes tables centrally and then distribute, is the easier option. **Distributed programming** is the more difficult implementation, which computes tables as a result of a distributed algorithm implemented in every router.
  - It is an open implementation of the control plane.

## 5.5.2 SDN Controller

- The **SDN controller** maintains network state information.
- It interacts with *network control applications* "above" using **northbound API**. The API allows network-control applications to read and write network state and flow tables in the state-management layer. Applications can register to receive notification when a state-change occurs.
- It interacts with *network switches* "below" using **southbound API**. It is communication between the controller and the controlled devices.
- It is implemented as a distributed system for performance, scalability, fault-tolerance, and robustness.
- See a diagram of the SDN controller relative to its northbound and southbound apps on **slide 5-63**.
- **Data plane switches** are fast and simple switches that implement generalized data-plane forwarding (packet-handling rules) in the hardware. The flow table is computed and installed by the controller, and an API is used for table-based switch control (like OpenFlow). It is a protocol for communicating with the controller (like OpenFlow).
- **Control applications** are the *"brains" of control*. They implement control functions using lower-level services and API provided by the SDN controller. They can be provided by a 3rd party, where they're distinct from routing vendors or SDN controllers. In such a case, they are *unbundled*.

### 5.5.3 Components of SDN Controller

- The **interface to the network-control application layer** has network control apps. It provides different types of APIs, such as ones for abstraction or for communication.
- The **network-wide state-management layer** contains up-to-date info about the state of networks, links, switches, and services.
- The **communication layer** communicates between the SDN controller and network controlled devices.
- See an example of interaction between the different planes on **slide 5-66 and 5-67**.
- There are challenges set to improve SDN by:
  - *Hardening the control plane* so that it's more dependable, reliable, and performance-scalable. It also doesn't hurt to be more secure.
  - Networks and protocols *meeting mission-specific requirements*, such as making it real-time, ultra-reliable, or ultra-secure in specific situations.
  - *Scale it* proportional to the Internet (which would actually be pretty hard to do).