$CS06201a01$: Network Computing and Efficient Algorithms

Lecture 12: SDN

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Review of related concepts

- What are Control plane and data plane?
- Are they always together in a device historically?
- Why separate control?
  - Rapid innovation: control independent of hardware
  - Network wide view: possible to infer and reason about network behavior
  - More flexibility: introducing new services rapidly

Review of related concepts

- Is OpenFlow SDN?
  - No. OpenFlow is an API that is standardized between control plane and data plane.
  - OpenFlow is an enabling technology for SDN. SDN may build over other enabling technology.

What is software defined networking?

- Software-defined networking (SDN) is an approach to computer networking that allows network administrators to manage network services through abstraction of lower-level functionality.
  - Abstractions for three problems: Constrained forwarding model, distributed state, detailed configuration
- SDN is
  - Directly programmable: network control is programmable because it is decoupled from forwarding functions
  - Agile: administrator can dynamically adjust network-wide traffic flow to meet changing needs.
  - Centrally managed: network intelligence is logically centralized.
  - Programmatically configured
  - Open standards-based and vendor-neutral

Forwarding abstraction

Control plane needs flexible forwarding model

- With behavior specified by control program applications
  - Use a generic flow concept that is inclusive and forward based on flows.
  - Historically the hardwares capability for forwarding is vendor dependent
  - e.g. forwarding based on L2 address, L3 address
- This abstracts away forwarding hardware
- Flexibility and vendor-neutrality are both valuable

State Distribution Abstraction

- Shield control mechanisms from state distribution while allowing access to the state
  - Split global consensus-based distributed algorithms into two independent components: a distributed (database) system and a centralized algorithm.
  - We know how to deal with both.
- Natural abstraction: global network view
- Implemented with a network operating system.
- Control (configuration) mechanism is now abstracted as a function of the global view using API
  - Control is now based on a centralized graph algorithm instead of a distributed protocol.

Network Operating System(NOS)

- NOS: distributed system that creates and maintain a network view
- Communicates with forwarding elements
  - Get state information from forwarding elements
  - Communicates control directives to forwarding elements
  - Using forwarding abstraction
- NOS plus forwarding abstraction = SDN (v1)

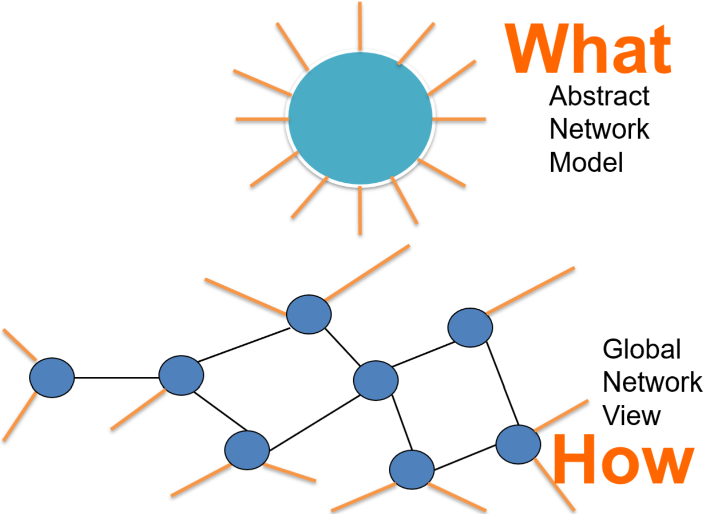
Configuration abstraction

- Application should not configure each individual network device.
- The NOS provide consistent global view of the network
- Configuration is a function of the global view
- NOS eases the implementation of functionality
  - Does not help specification of functionality
- Need a specification abstraction

Specification abstraction

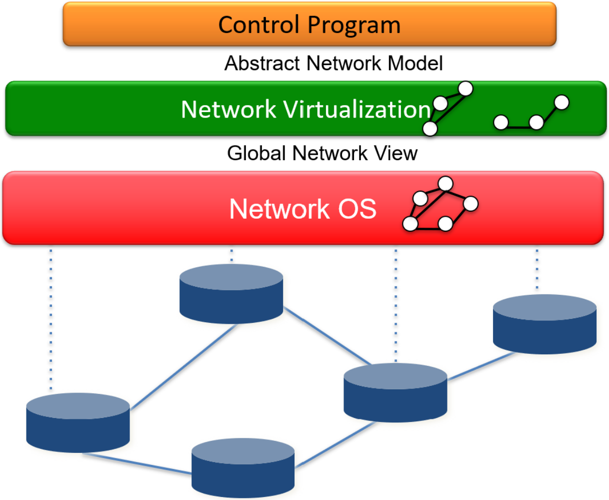
- Given control program abstract view of network
  - Abstract view is a function of global view. The abstract view could be just a giant switch connecting all ports, or individual logical topology for each application.
- Control program is abstract mapping
  - Abstract configuration = Function (abstract view)
- Abstraction models should have just enough detail to specify goals
  - Dont provide information needed to implement goals

Simple Example: Access Control



Note: Credit to Scott Shenker, UC Berkeley

Architecture by Scott Shenker, UC Berkeley



Architecture by Scott Shenker, UC Berkeley

Write a simple program to configure a simple model

- Configuration merely a way to specify what you want

Examples:

- ACLs: who can talk to who
- Isolation: who can hear my broadcasts
- Routing: only specify routing to the degree you care Some flows over satellite, others over landline
- Specify in terms of quality of service, not routes
- Virtualization layer compiles these requirements Produces suitable configuration of actual network devices NOS then transmits these settings to physical boxes

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