Software-Defined Networking
- Attributes, candidate approaches, and use cases -

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Why SDN from Operators’ perspective?

- Intelligence on networks and resource sharing
  - A lot of the information is stored and processed on computers out on the network
    - Data center, distributed clouds, etc.

- Programmability
  - Add operators’ own processing, control, program, etc.
    - More intelligent control systems to orchestrate the behavior of thousands of routing machines

- Service awareness
  - E.g., On-demand “express lanes” with guaranteed QoS for voice and data traffic that is time-sensitive

- Management and Operations
  - Much easier to reduce management complexity rather than in configured networks
    - Optimize resources, Decrease energy consumption
    - CAPEX/OPEX reduction (cheap NEs)
Today's Network vs. SDN

Data Plane
(Specialized Hardware)

Control Plane
(Network OS)

Network Operators

Contents
Server

Dumb Pipe

Smart Pipe

Network Operators

Contents
Server

Controller
(Software)

Abstract Network Model
(Open API, Script, Language)

(e.g.) Openflow
protocol

Client

Data Routing

Mobility

Energy efficient forwarding

Virtualized Programmable Infrastructure

A Single Physical Infrastructure
SDN - Attributes

(1) Separation of data and control planes

(2) Open interface to control planes

(3) Open interface between control and data planes

(4) Virtualization and slicing of the underlying network
SDN – Candidate Approaches ?

(1) Separation of data and control planes
   ➢ Abstract Network Model ?

(2) Open interface to control planes
   ➢ Abstract Network Model → APIs, Script, Formal description languages, etc.

(3) Open interface between control and data planes
   ➢ E.g., OF Extensions …

(4) Virtualization and slicing of the underlying network
   ➢ Virtualization of resources (VM, Rspec, etc.)
Use Cases and Goals

• Data center and distributed clouds
  – Increase network functionality while lowering the cost associated with operating networks
  – Optimize resources (business-driven)
  – Decrease energy consumption (route planning)
• Home network management
  – Avoid complexity of management for heterogeneous devices
  – Access broker
• Mobile operator
  – MVNO extensions
  – Service Component Mobility
• Campus networks and testing
  – Experimentation (e.g., GENI racks, Beta slice)
  – Polymorphic networks (e.g., CCN + IP legacy routing)
Challenging Issues (In-Scope ?)

• Scalability
  – A single controller : a single point of failure
  – Inter-domain issues

• Interoperability
  – Multi-controllers, multi-operators, etc.

• Security
  – Controllers attacked
    • Malicious controllers destroy whole networks

• Validation and verification (of dynamically defined networks)

• Carrier grade

• Monitoring