Software-Defined Networking

- Attributes, candidate approaches, and use cases -

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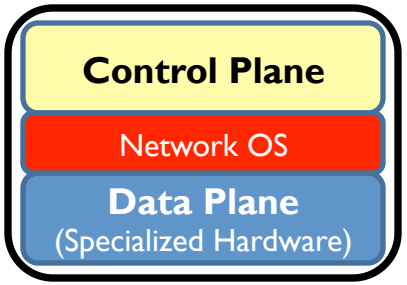
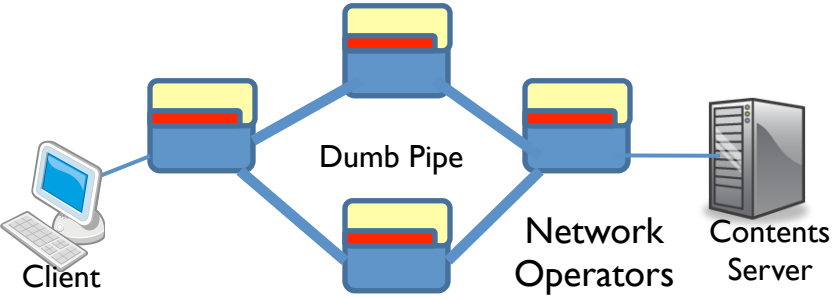
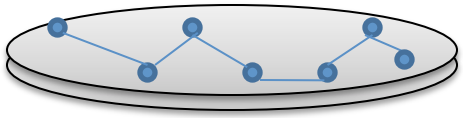
Why SDN from Operators' perspective ?

- 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 thousa nds of routing machines
- Service awareness
  - E.g., On-demand "express lanes" with guaranteed QoS for voice and data t raffic that is time-sensitive
- Management and Operations
  - Much easier to reduce management complexity rather than in c onfigured networks
    - Optimize resources, Decrease energy consumption
    - CAPEX/OPEX reduction (cheap NEs)

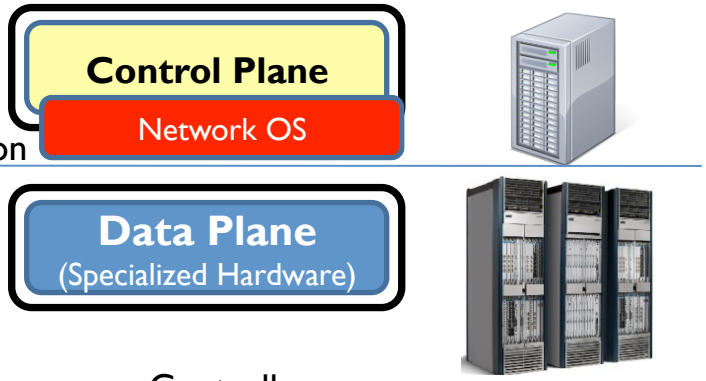
Today's Network vs. SDN

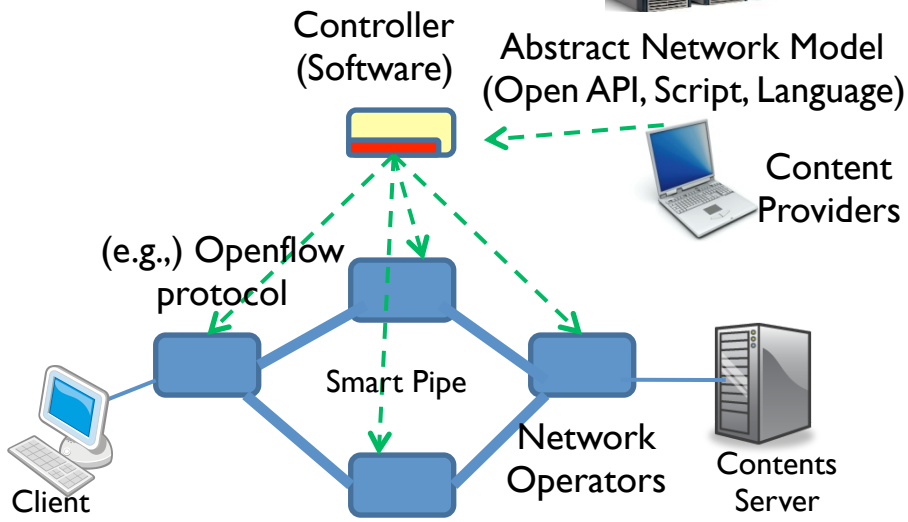


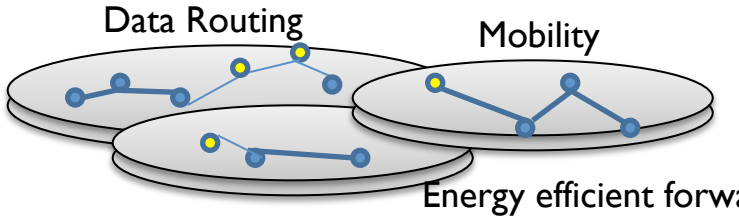




A Single Physical Infrastructure







Virtualized Programmable 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 associate d with operating networks
  - Optimize resources (business-driven)
  - Decrease energy consumption (routing 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