



# Introduction to Software Defined Networks

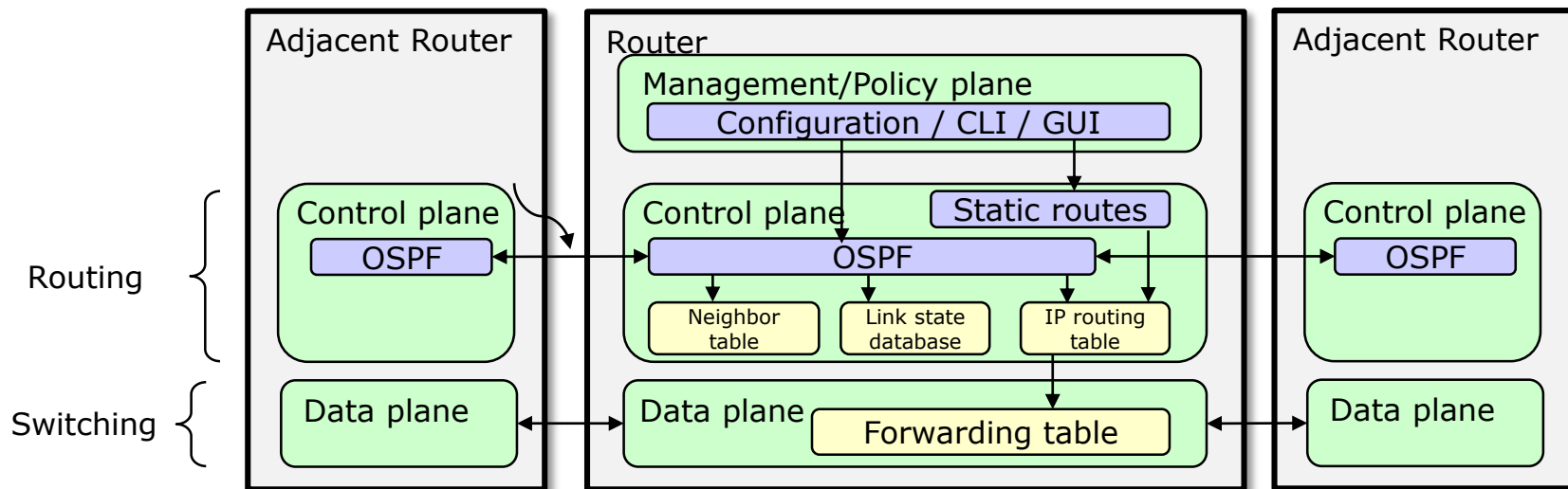
Fulvio Riso

Politecnico di Torino



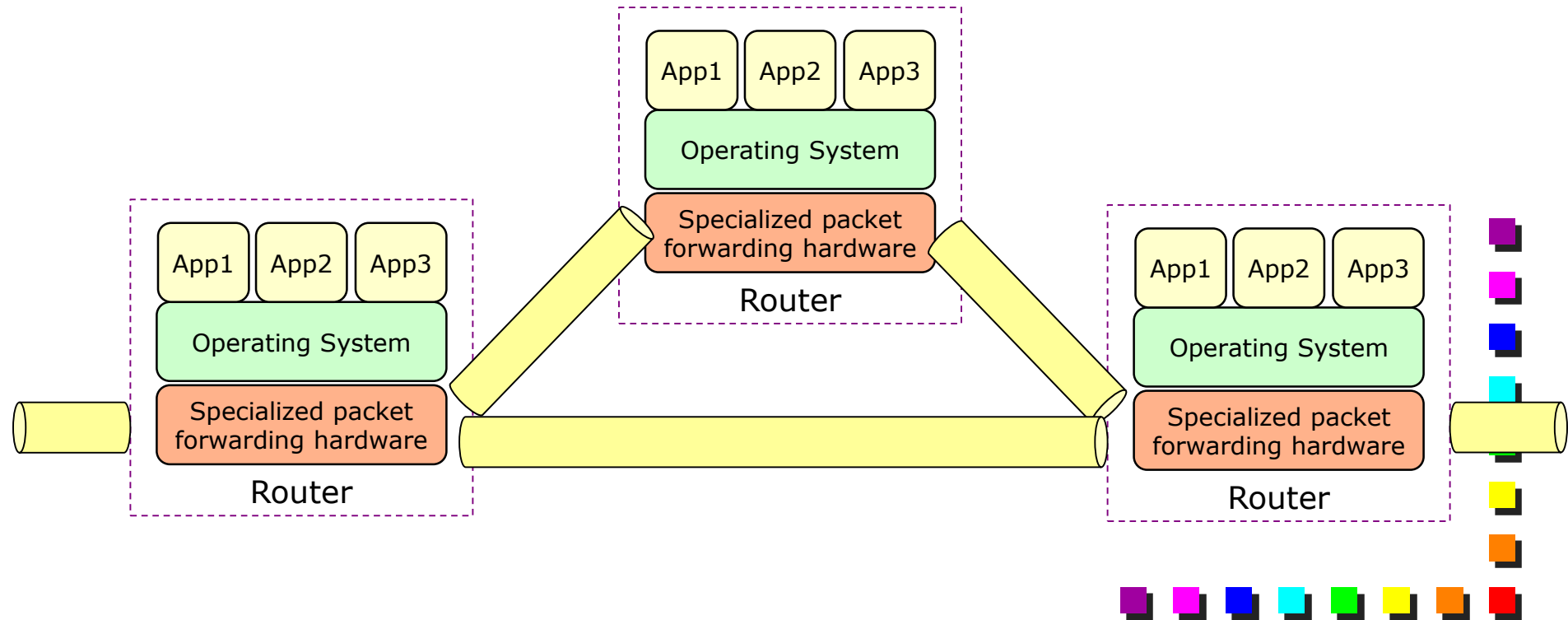
# Traditional Network Router

- Router (but in general, any network device) can be partitioned into a **control** and **data plane**
  - Management plane/ configuration
  - Control plane / Decision: OSPF (Open Shortest Path First)
  - Data plane / Forwarding

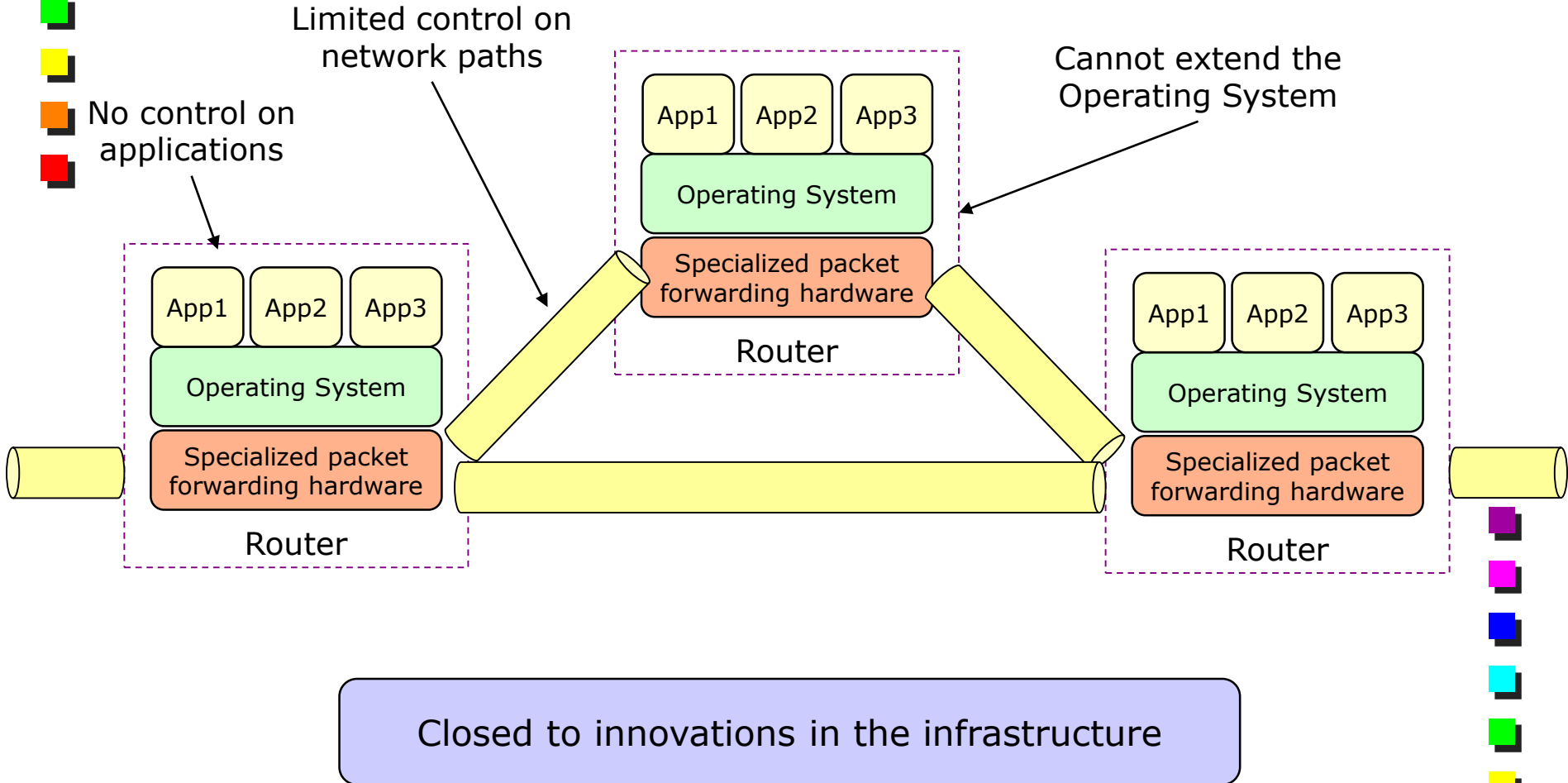


# The Internet, after 30+ years (1)

- Internet is still the one we defined 30 years ago
  - Almost the same protocols, same philosophy
- Internet is a very efficient pipe that transports bits at very high speed

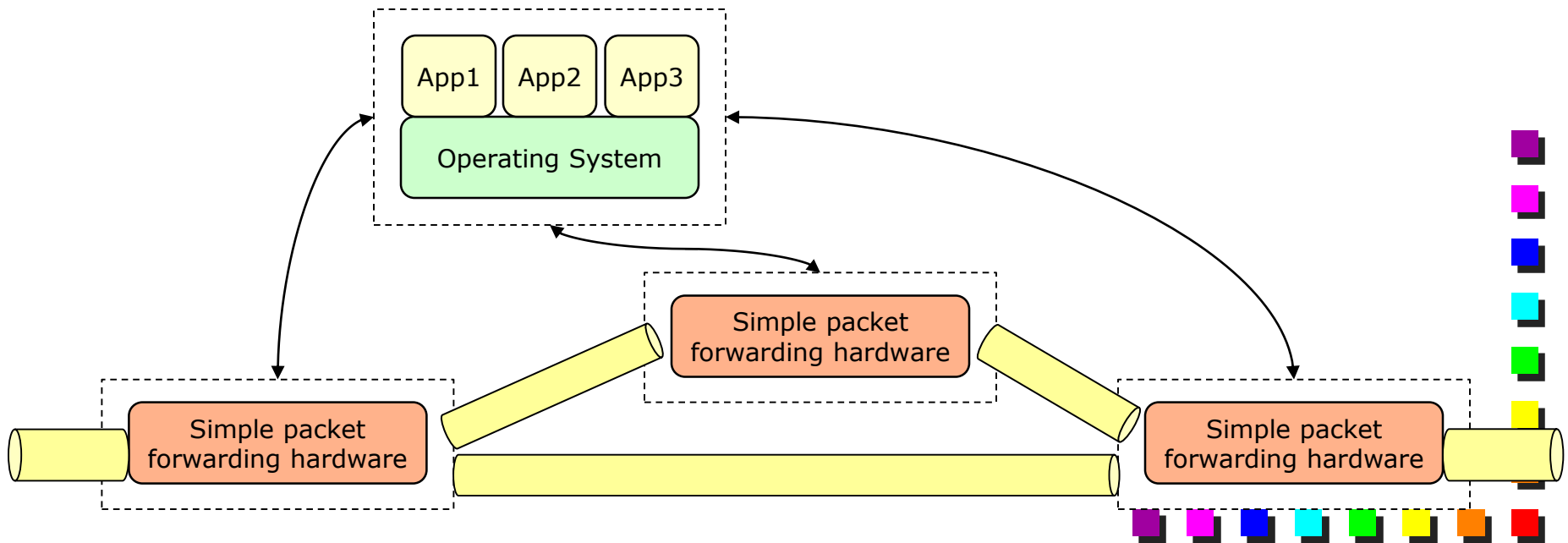


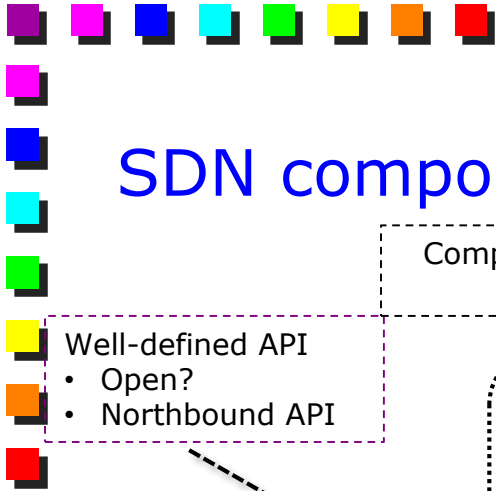
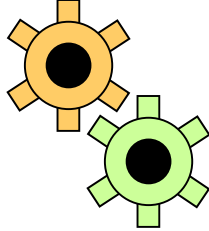
# The Internet and the difficulties to innovate



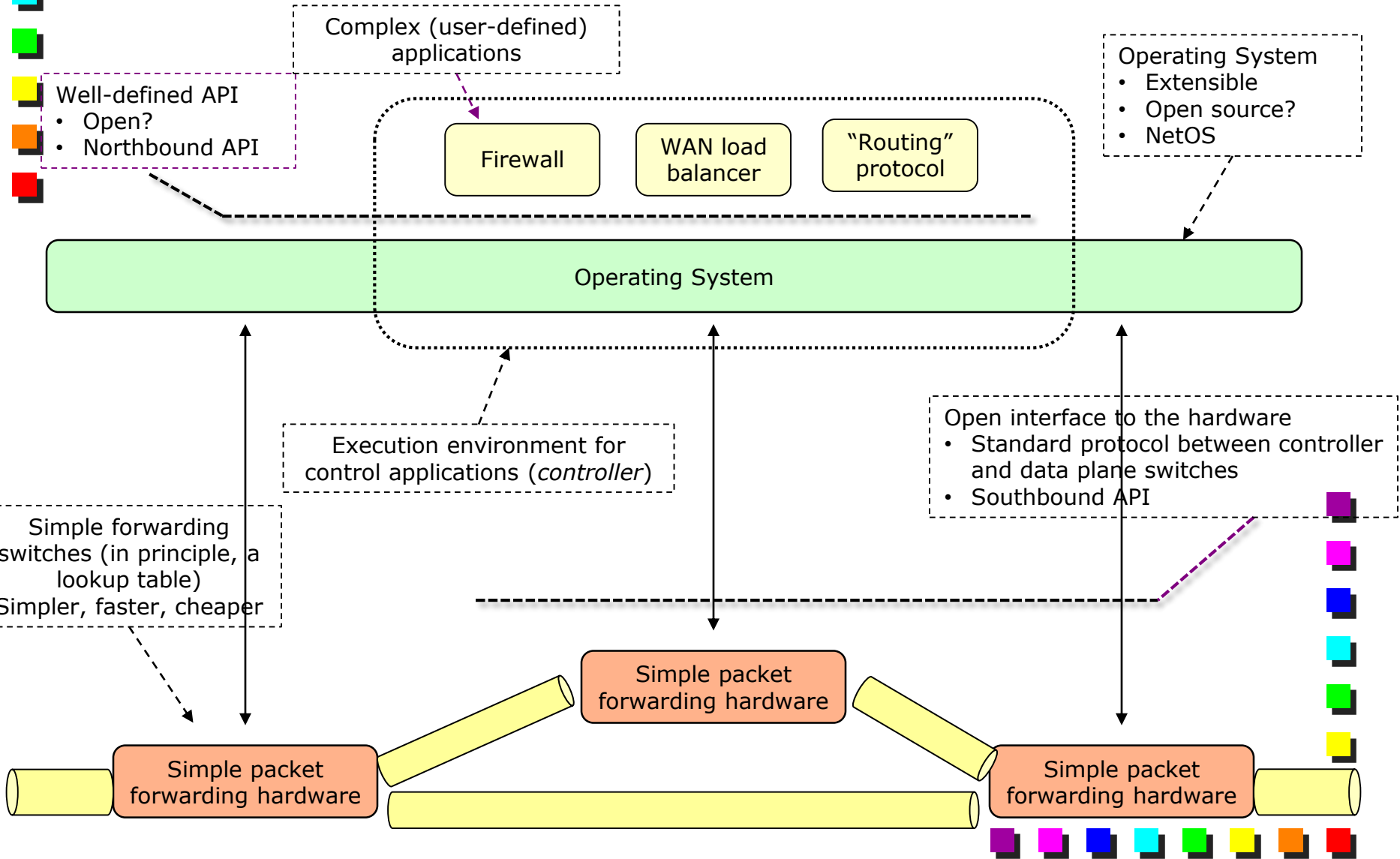
# Software Defined Networks

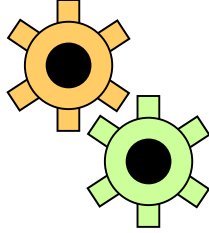
- Paradigm that introduces the possibility to **program** the **network**
- Based on three pillars
  - Separation of control and forwarding functions
  - Centralization of control
  - Well-defined interfaces (northbound and southbound)



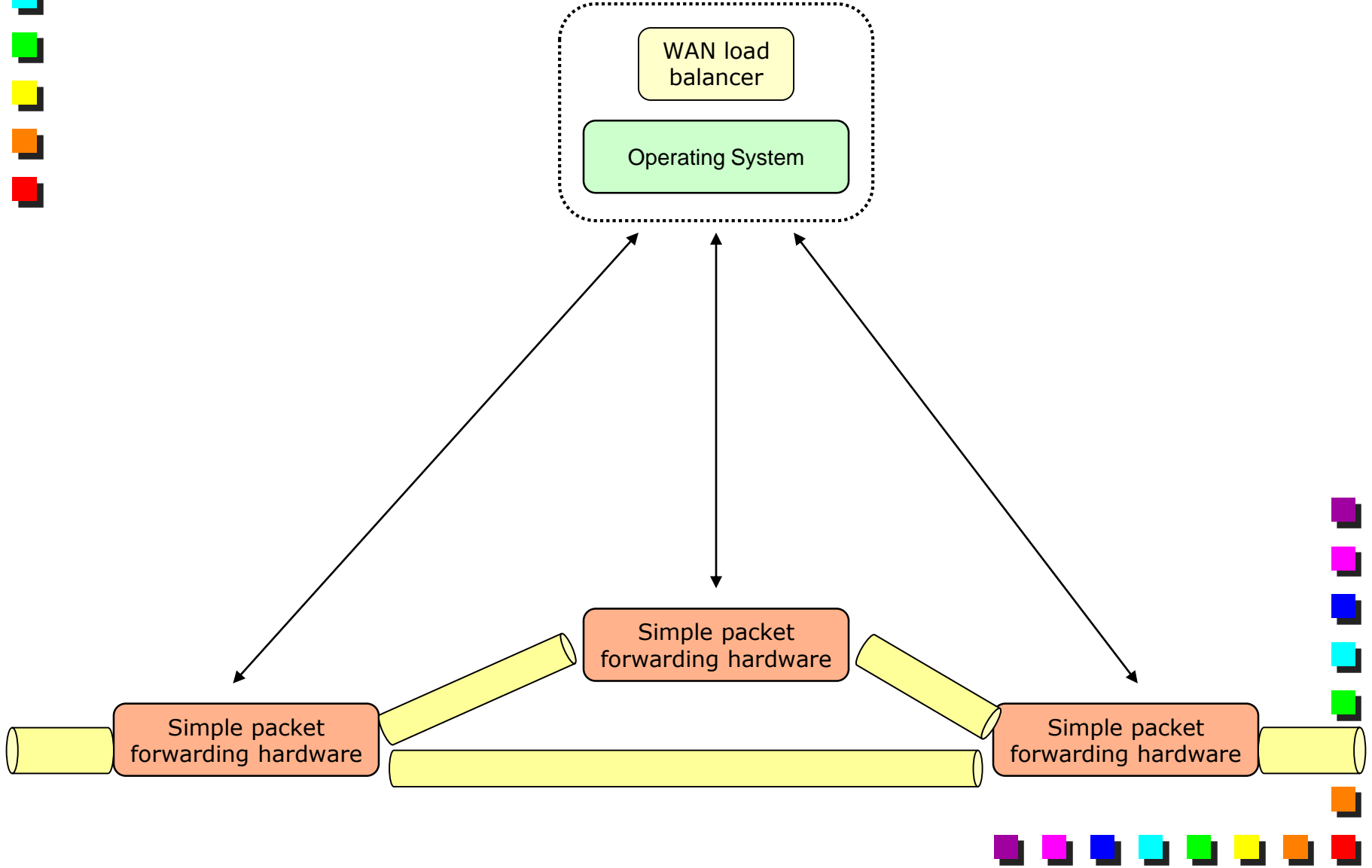


# SDN components



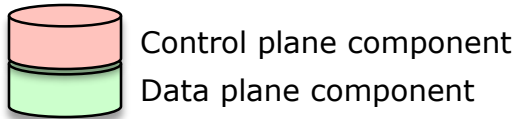
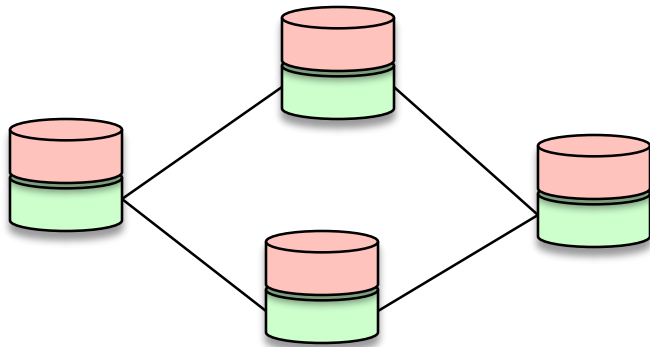


# An SDN packet flow example

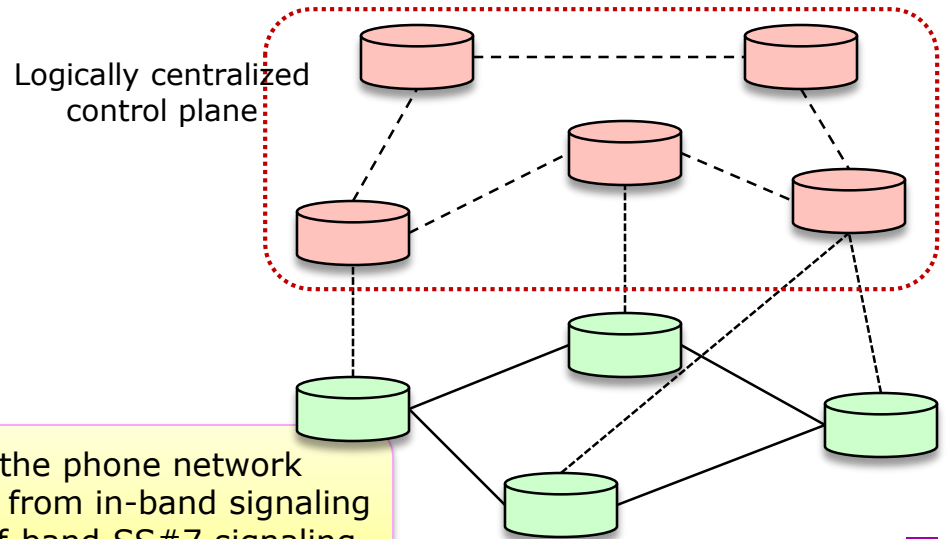


# Software Defined Networks in essence

Traditional control plane architecture



Control plane architecture with SDN



Also the phone network migrated from in-band signaling to out-of-band SS#7 signaling some years ago

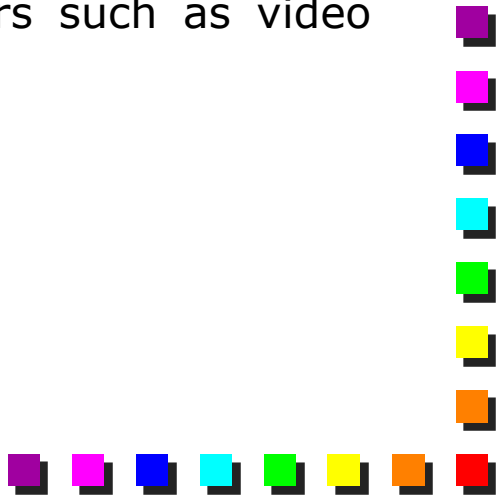
SDN is an approach to architecting the network control plane, where the behavior of the network is determined by software which is **logically separated** from the network devices.

This software could run in the network devices, a set/cluster of dedicated central server, application servers – or any combination of those.



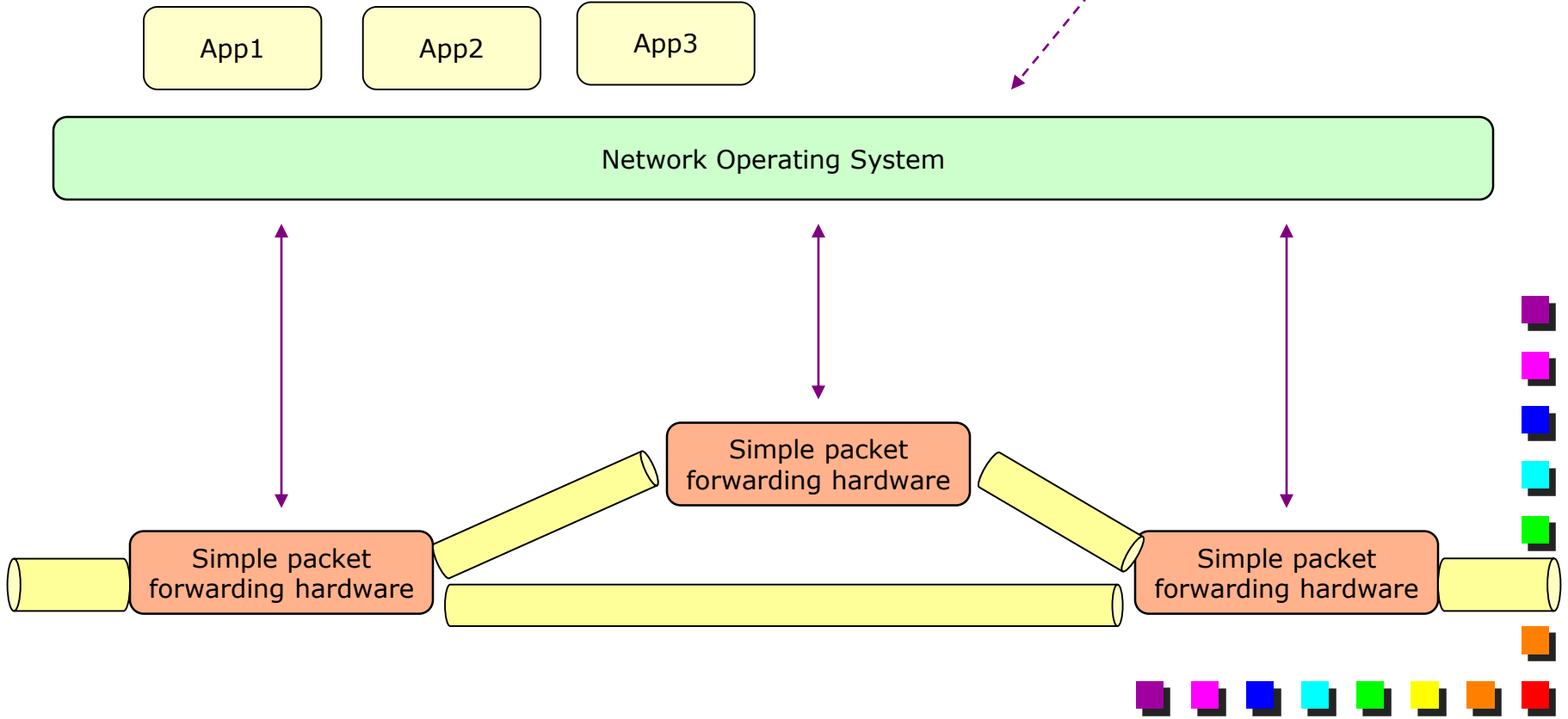


## Software Defined Networks

- Software from third parties (e.g., network operators, residential customers, enterprise managers, datacenter operators) can be installed that can control network devices
  - What does “control” mean?
    - Currently, “control” means mainly “control plane”
    - We can implement new “routing” protocols (e.g., customize paths for network engineering)
    - Create network slices “private” to different entities (e.g., virtual network operators, application service providers such as video streaming, CDN, etc)
- 

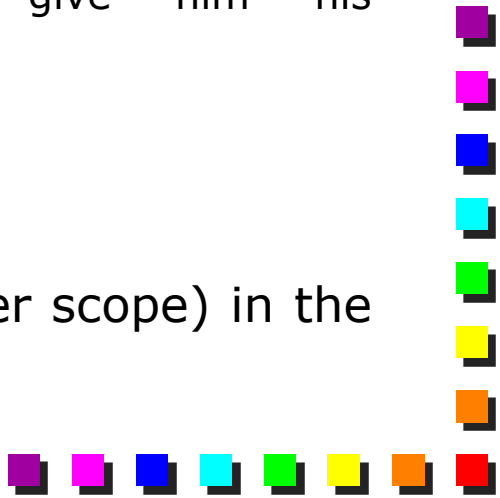
# Network Operating System

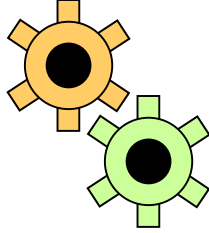
- Possible functions
- Synchronization between different physical controllers
  - Virtualization of the network topology
  - Single "logical" configuration transformed into multiple "physical" commands





# Network Operating System

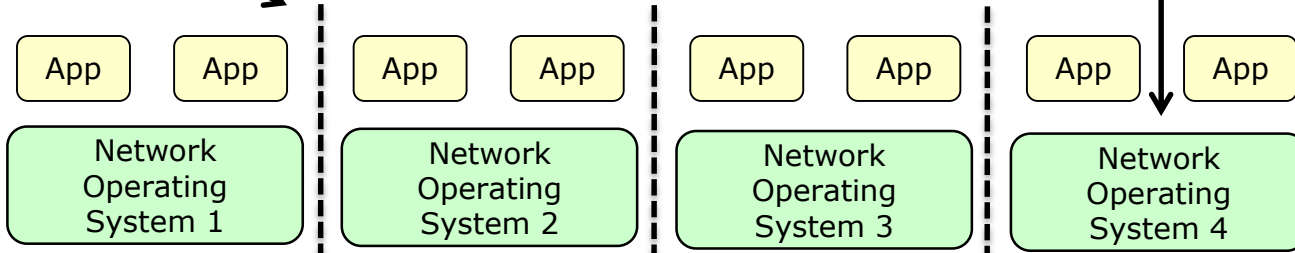
- Software layer that offers a “global” view of the network to upper applications
    - Right now, we have to configure each single device
      - VLAN, access lists, policies, QoS, ...
      - The configuration may be incoherent on different devices
    - A NetOS wants to give us the possibility to setup and application that operates across the whole network
      - E.g., check that a new user that connects to the network (from any port) is not infected; if so, give him his privileges/configuration
  - “Easy” to implement in a centralized controller
  - NetOS may have more features (and a broader scope) in the future
- 



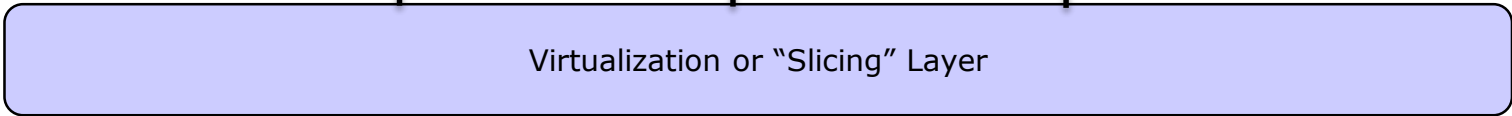
# SDN and slices

Isolated "slices"

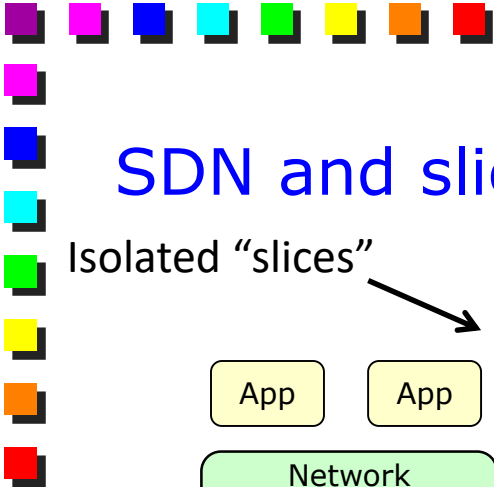
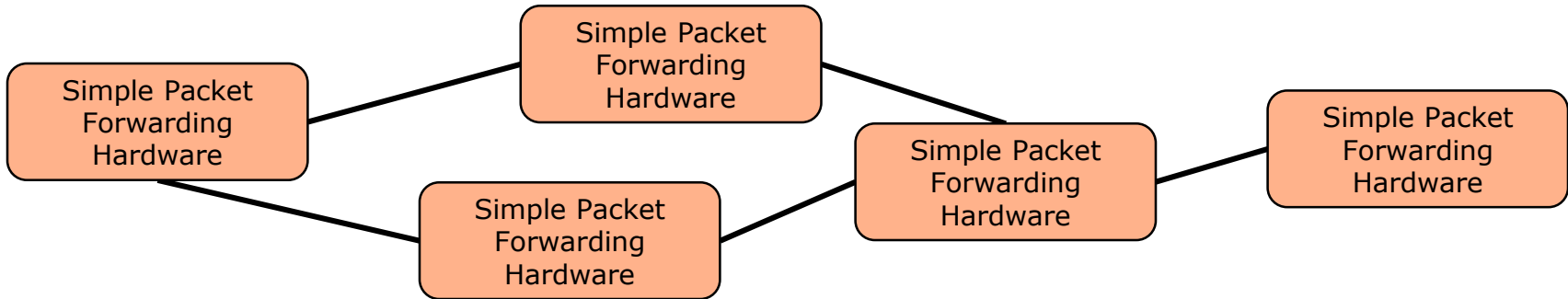
Many operating systems, or  
Many versions



} Open interface to hardware



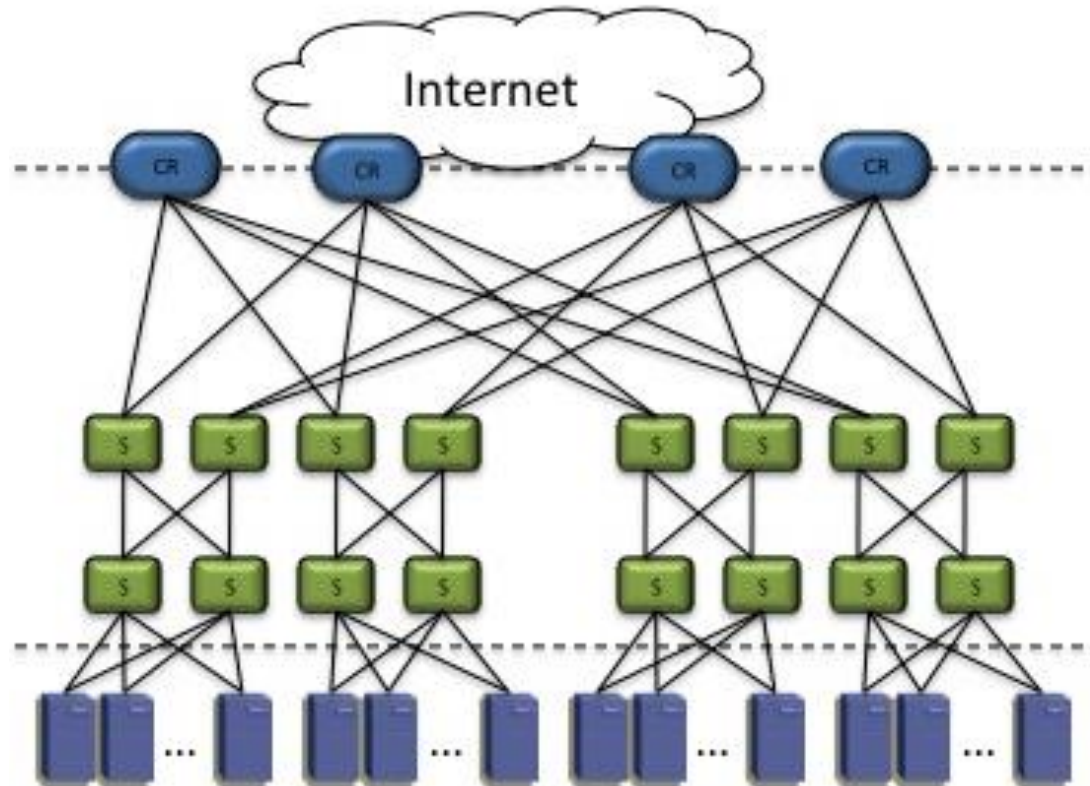
} Open interface to hardware





# SDN applications

- Path optimization
  - Fat trees
- Traffic engineering
  - Per flow paths
- Virtual circuit emulation
  - VM migration
- Service chaining
  - (presented later)





# SDN deployment

- Stable, local networks
  - Datacenters
  - Enterprise
- Edge services (possible)
  - Service chaining model
- No network service providers so far
  - Except Google





## The good and the bad of SDN

### Good

- Network virtualization (slicing)
  - E.g., virtual operators, VPNs with network (not only edge) support
- Network operating system
- Network API
- Network as an unique entity

### Bad

- Simple packet forwarding hardware
    - Against the interest of major network vendors
    - Not scalable (hardware speedup needed)
  - Focus only on the *network*
- 