

CS 725/825 & IT 725

Lecture 21

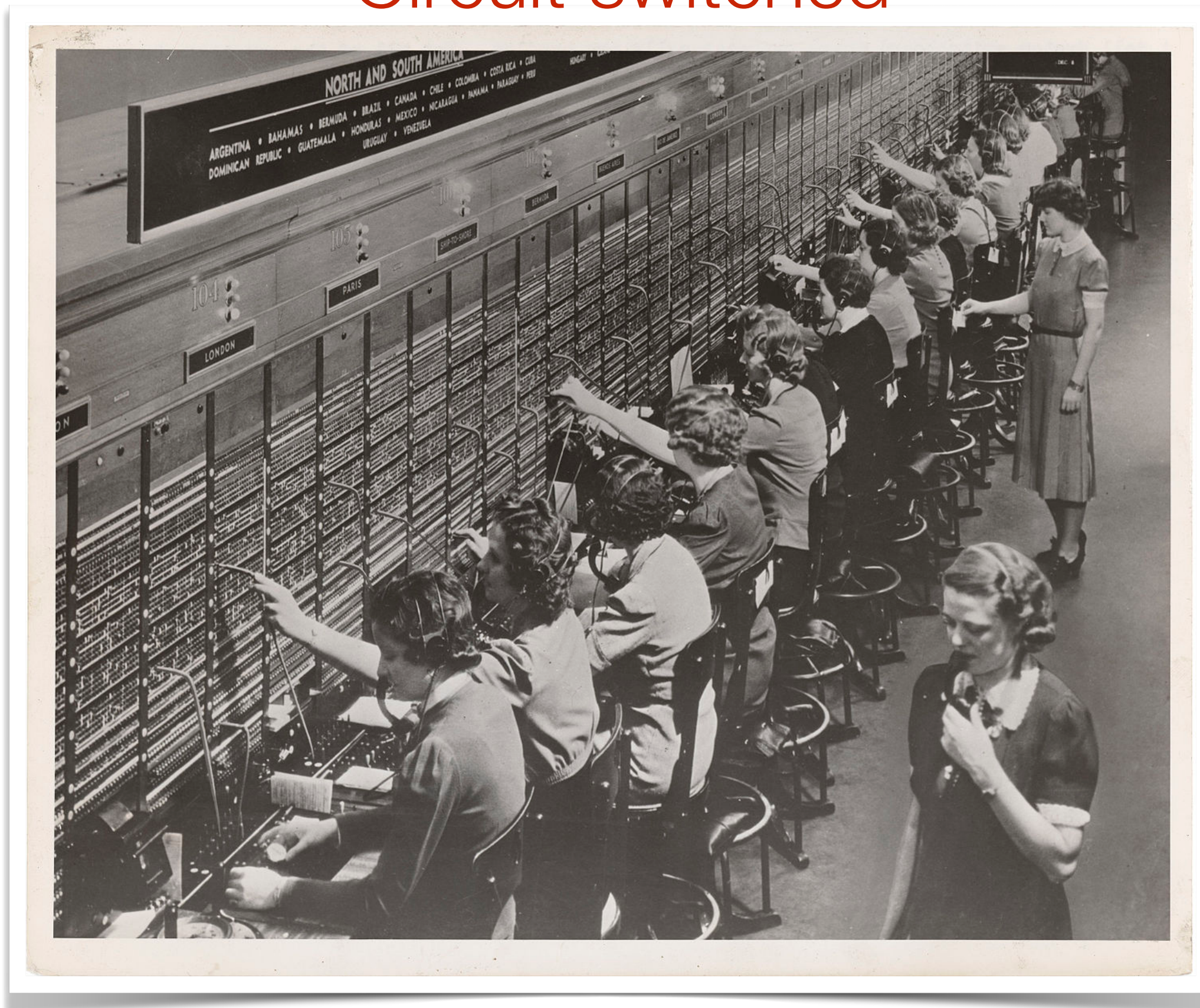
Network and Link Layers

November 18, 2024

Categories of Networks

- ▶ Compromise: virtual packet switched

Circuit switched



Packet switched



Virtual Circuits

- ▶ Problems with packet-switched networks:
 - no connection between packets
 - difficult to provide QoS
 - difficult to provision resources
 - difficult to control routes the packets take
 - reactive fault-tolerance
- ▶ All these problems can be addressed in circuit-switched networks

Circuits vs Virtual Circuits

▶ Virtual Circuit Switched Networks

- an overlay on top of a packet switched network that provides a circuit-based service
- “most of the benefits at a fraction of the cost”
- trading ability to control for loss of simplicity

▶ Always the next big thing

- OSI - Open System Interconnect (R.I.P.)
- ATM - Asynchronous Transfer Mode (R.I.P.)
- MPLS - MultiProtocol Label Switching (alive and well)

Virtual Circuit Switching

- ▶ Virtual Circuit (VC)
 - separation of routing and forwarding
- ▶ Circuit Switching Table
 - state-full forwarding
- ▶ Virtual Circuit Identifier (VC id)
 - global circuit vs locally significant circuit identifier

MPLS

▶ MultiProtocol Label Switching

- a protocol providing virtual circuit service
- designed to coexist and complement existing protocols, not to replace them

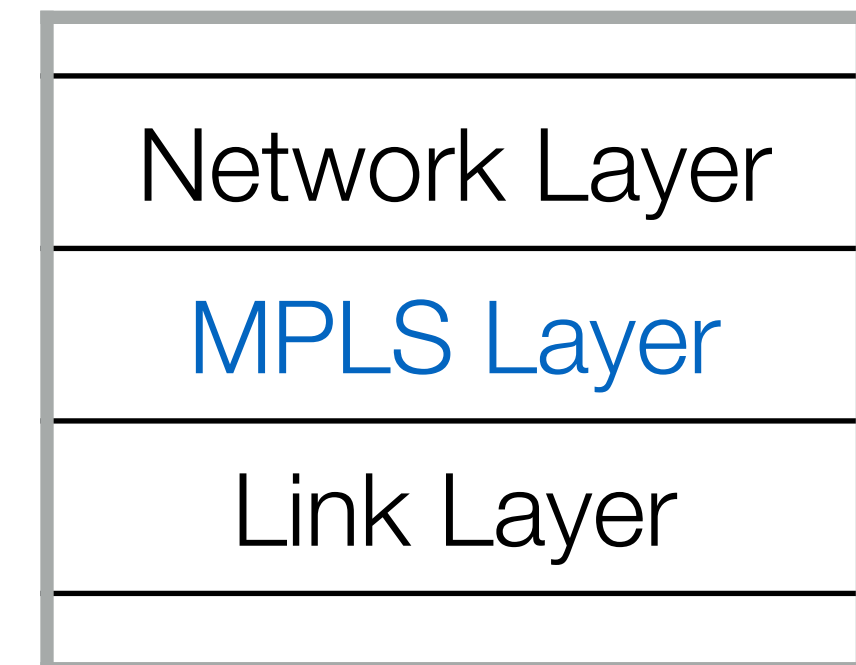
▶ One protocol, many uses:

- simplification of forwarding
- traffic engineering
- protection and restoration
- support for legacy services
- VPNs,

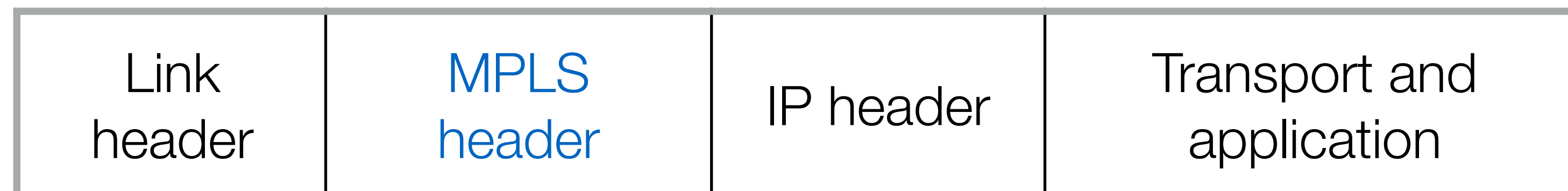
MPLS Terminology

- ▶ **Label Switched Path (LSP)**: a VC
- ▶ **Label**: VC id
- ▶ **Label Switch Router (LSR)**: a switch
- ▶ **Forwarding Equivalence Class (FEC)**

Typically:



MPLS packet



SDN

▶ Software Defined Networks

▶ Motivation:

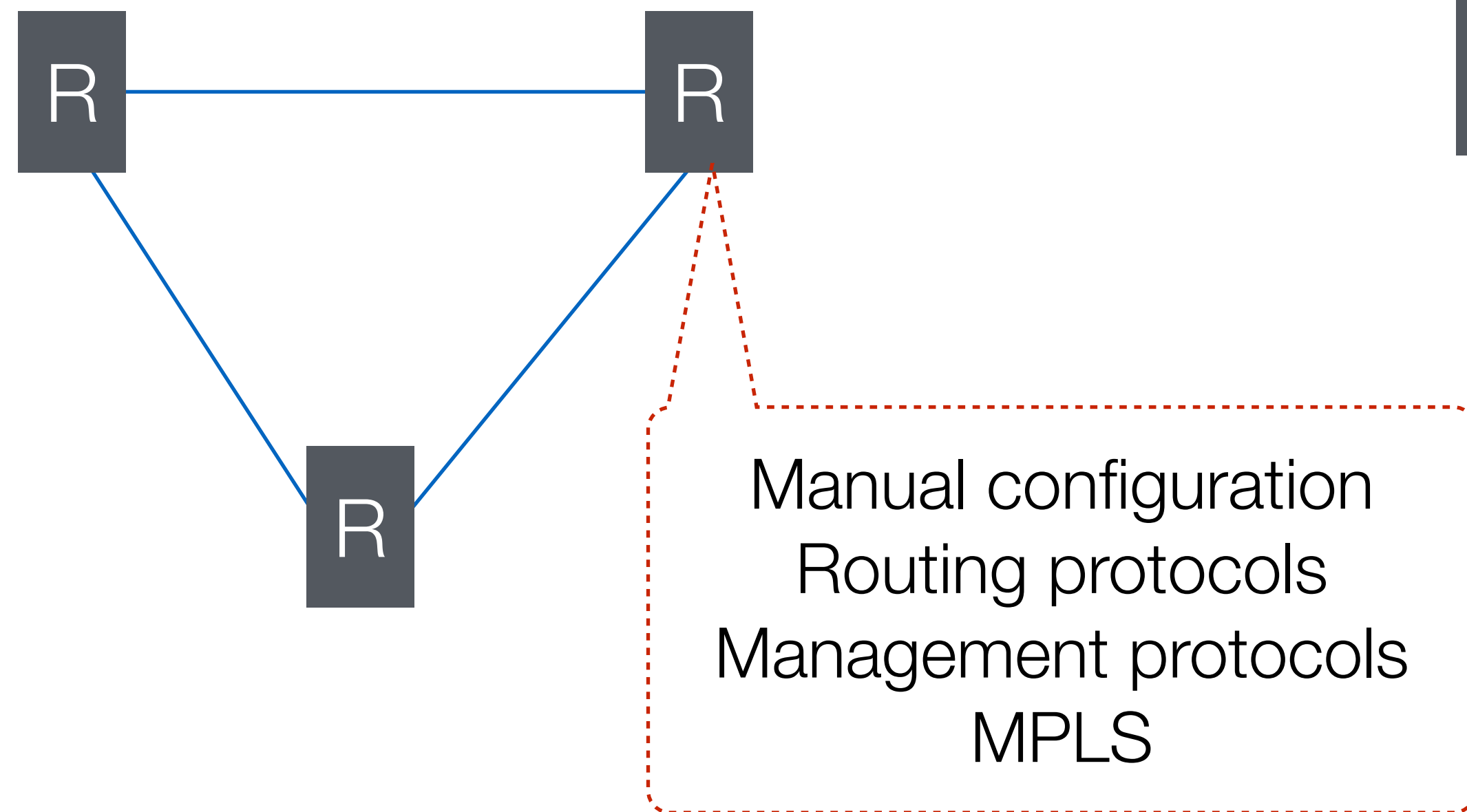
- many protocols, vendors, management platforms
- virtualization, cloud, ... (fill the buzzword of a day)
- scale up in size and bandwidth

▶ Goals:

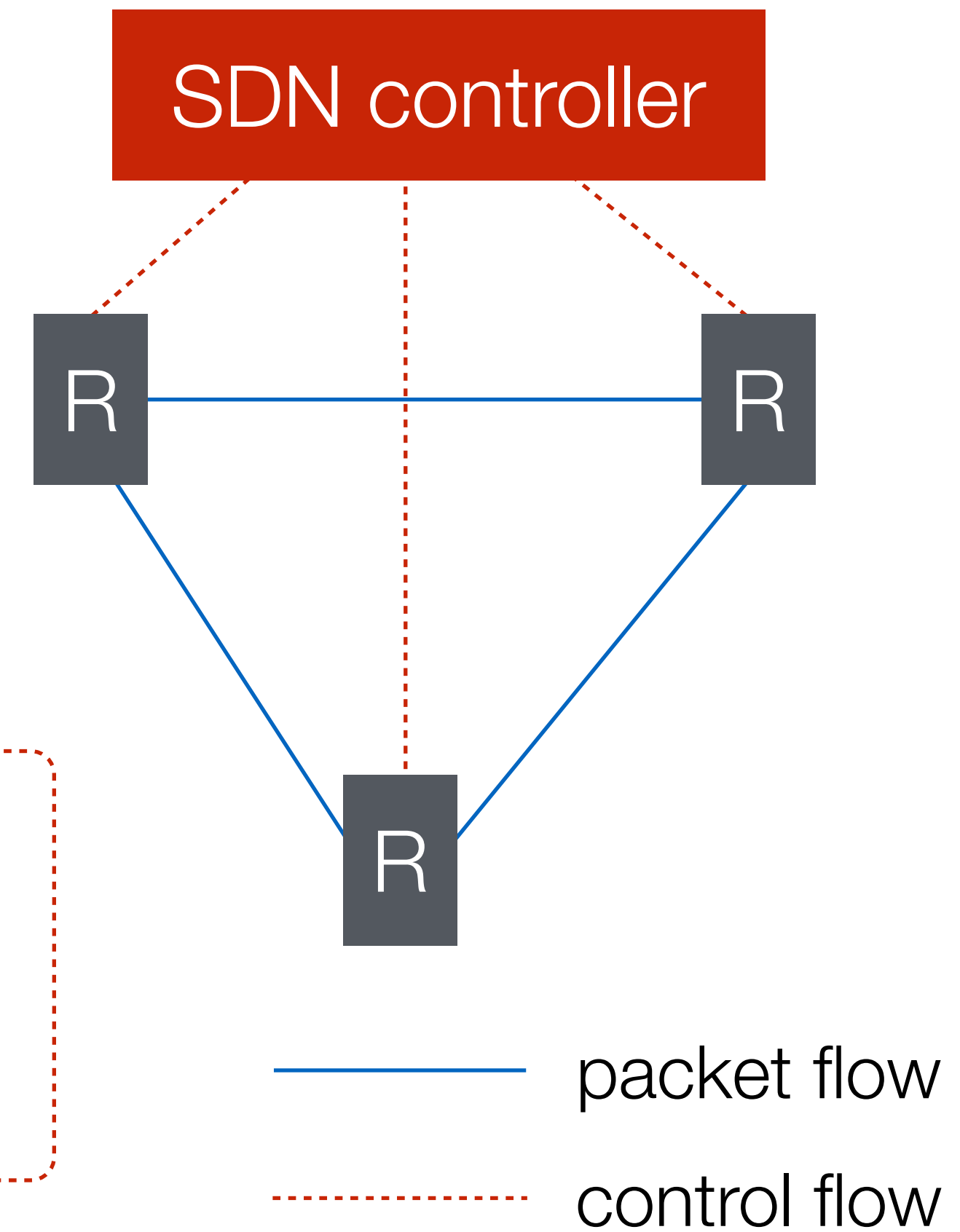
- flexibility, agility, ...
- central management, programmatically configured (API)
- open and vendor-independent

SDN

Traditional approach

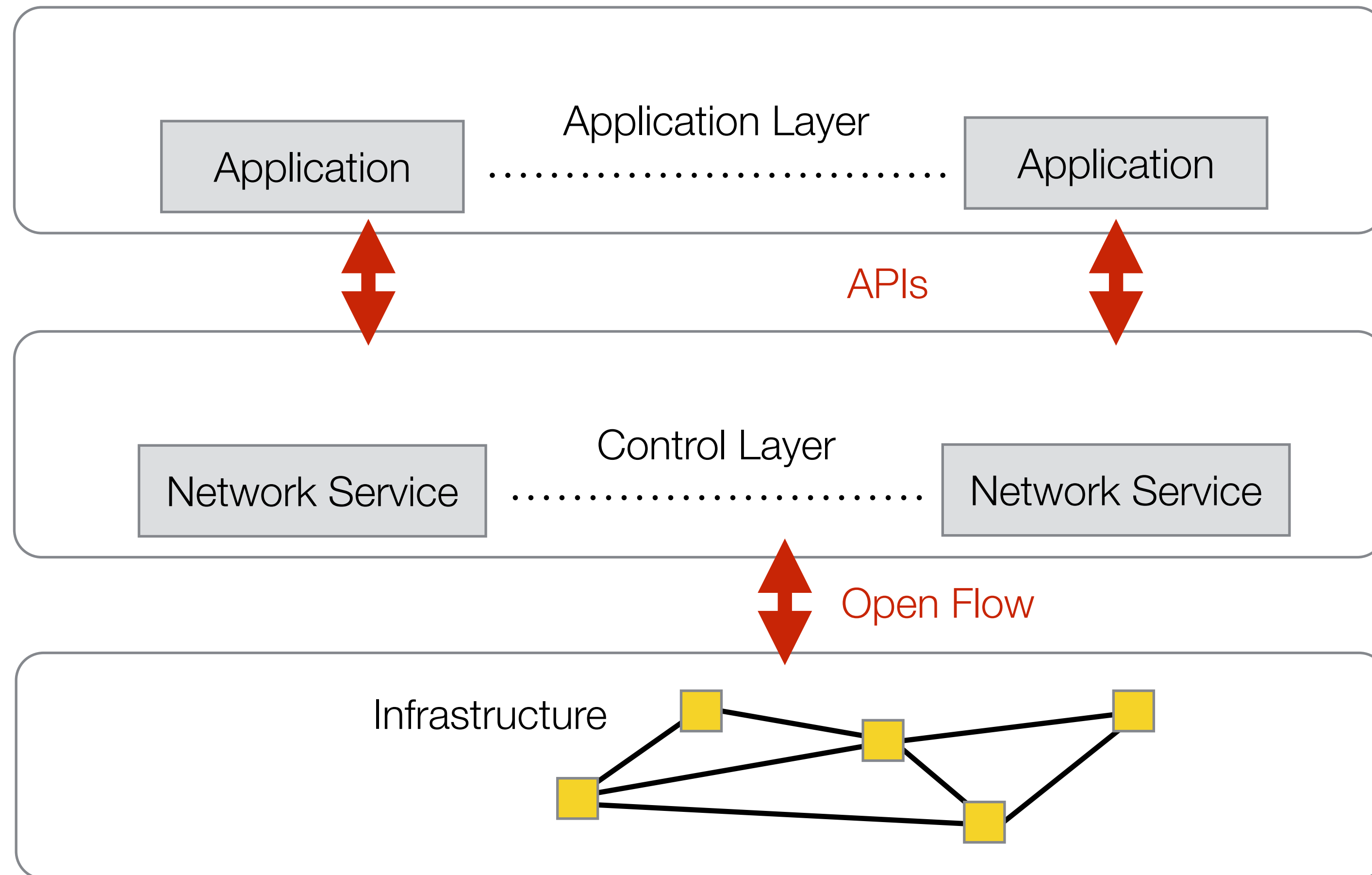


Software Defined Networks (SDN)



SDN Architecture

► Grossly simplified:



Link Layer

Channel Capacity

- ▶ Shannon's (noisy-channel coding) Theorem:

$$C = B \cdot \log_2 \left(1 + \frac{S}{N} \right)$$

C - channel capacity

B - channel bandwidth

S/N - signal to noise ratio

Multiplexing

... allowing multiple simultaneous transmissions

- ▶ “Space multiplexing”
- ▶ Time Division Multiplexing (TDM)
- ▶ Frequency/Wavelength Multiplexing (WDM)
- ▶ Code Division Multiplexed Access (CDMA)