Skoltech

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Software-Defined Networks (SDN)

Lecture 1: SDN Basics

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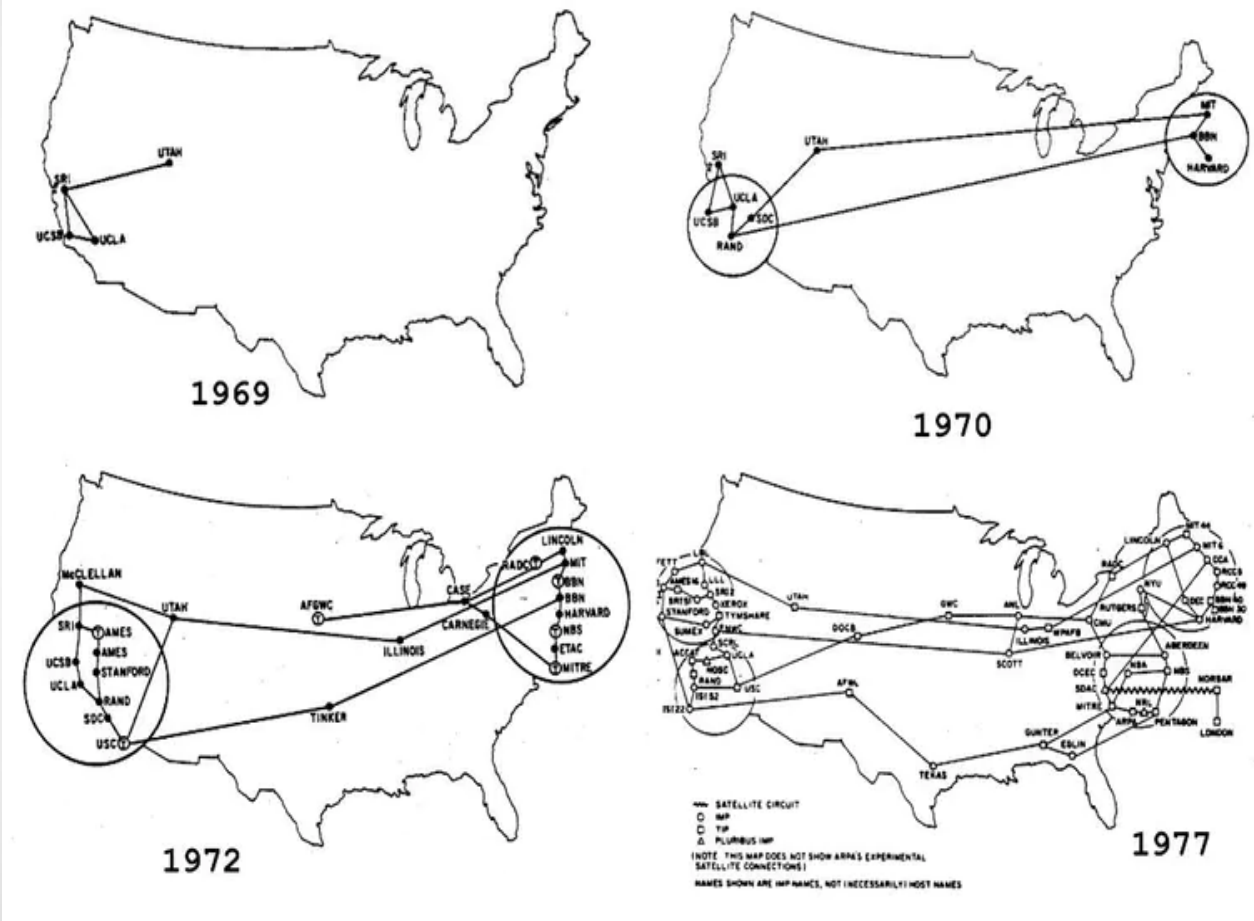
Lecture Outline

1. **Traditional computer networks:**
   - Traditional network architecture
   - Problems of traditional networks
2. **Software-defined networks (SDN):**
   - Motivation for the transition to SDN
   - SDN Principles and Architecture
   - Advantages and disadvantages of SDN
   - SDN history
3. **Network operating system (SDN controller):**
   - Controller tasks
   - SDN controller requirements
4. **SDN Stack**

1. Traditional computer networks

ARPANET



***A**dvanced **R**esearch **P**rojects **A**gency **Net**work*

- 1969 year
- DARPA Agency
- Internet prototype

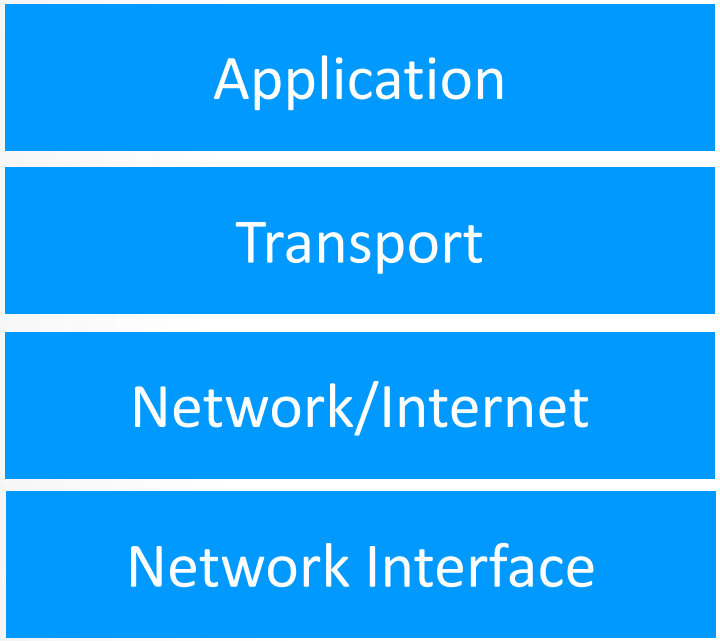
Goals:

- Ensuring connectivity
- Ensuring survivability

Internet architecture

- Multiple layers
- Data encapsulation principle
- Packet switching principle

TCP/IP Model



Application Layer:
HTTP, SMTP, DNS, Telnet, SSH, FTP

Transport Layer:
TCP, UDP

Internet Layer:
IPv4, IPv6, Ipsec, OSPF, EIGRP, IS-IS, NAT

Network Interface Layer:
Ethernet, IEEE 802.11, PPP

Internet

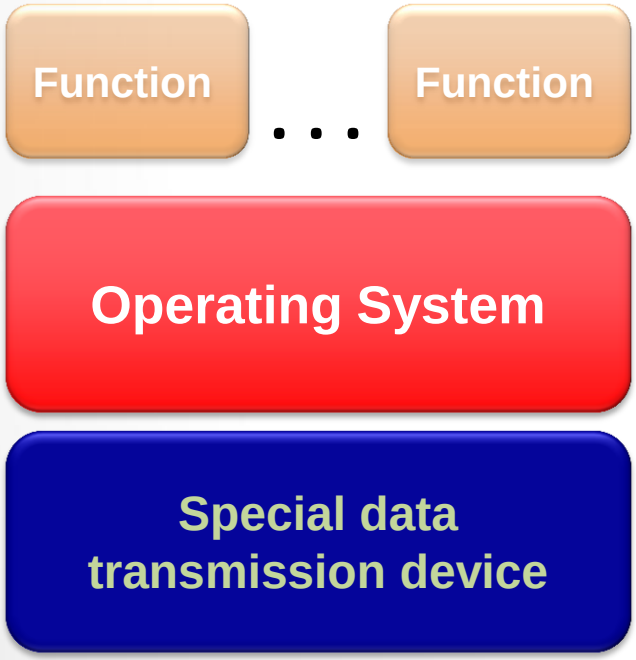
Principles of building the Internet:

- Simplicity
- Intelligent hosts
- Distributed control

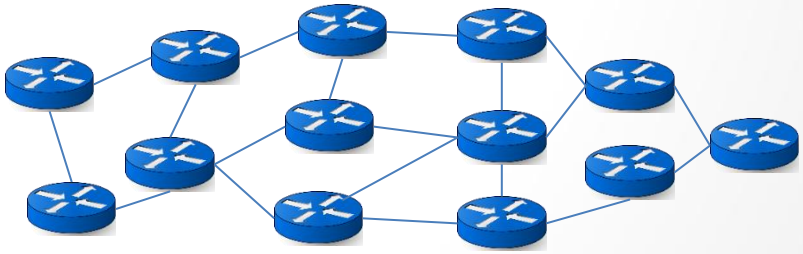
Result:

- Huge complex network
- Complex controls
- Complex devices (routers)
- Billions of hosts
- Tens of thousands of speakers
- Big business

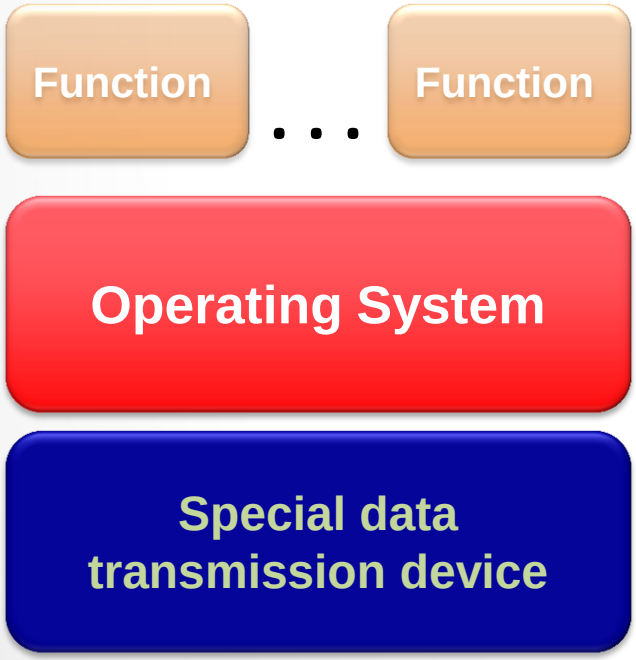
Problems of traditional networks



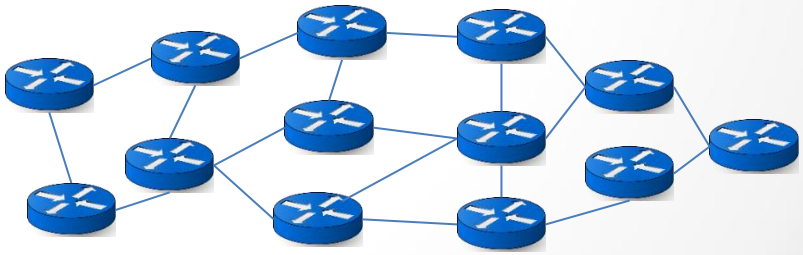
1. Vendor dependence
2. Errors in network protocol implementations
3. Millions of lines of closed proprietary code (6000+ RFCs)
4. High cost of equipment
5. High operating cost



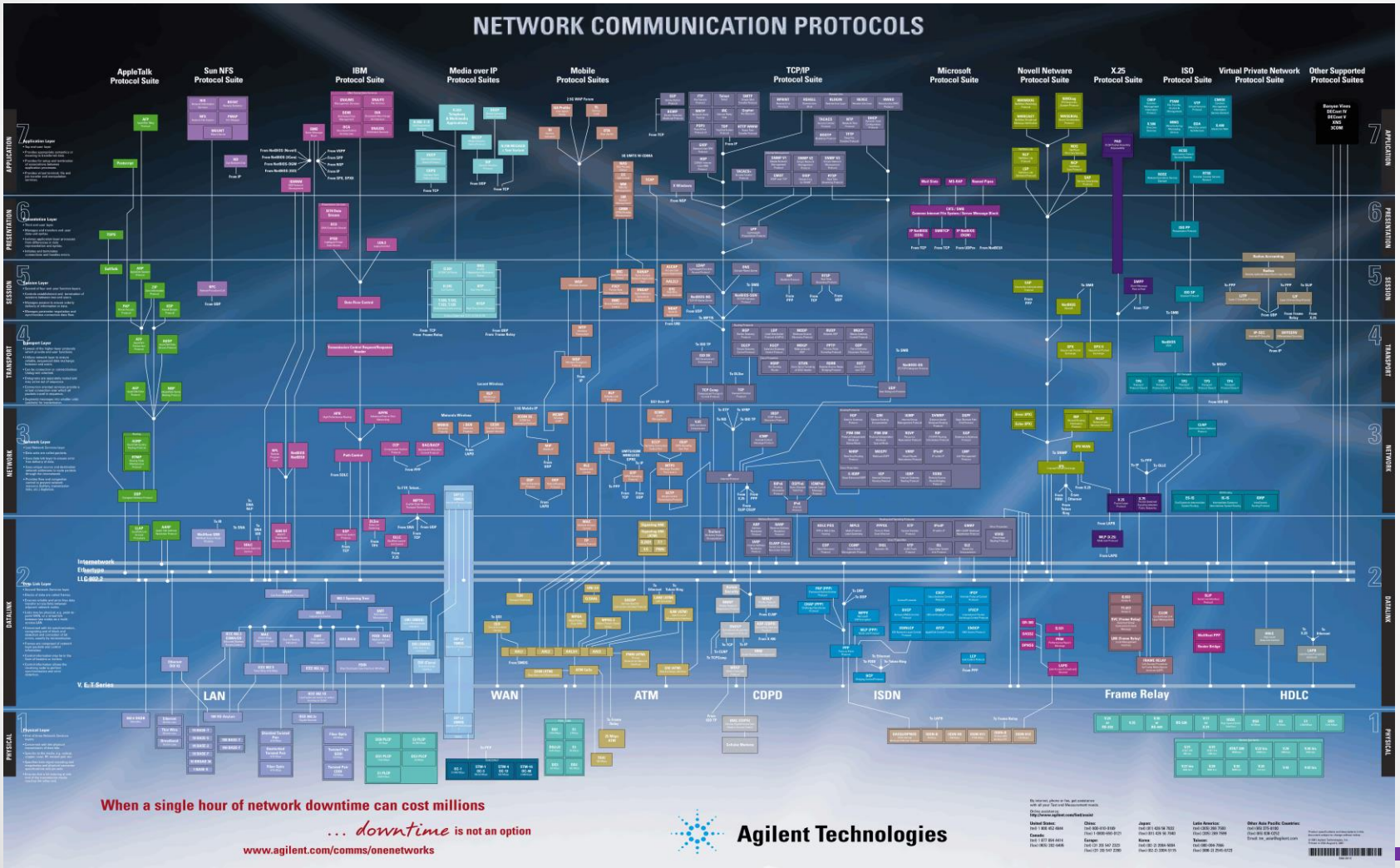
Problems of traditional networks



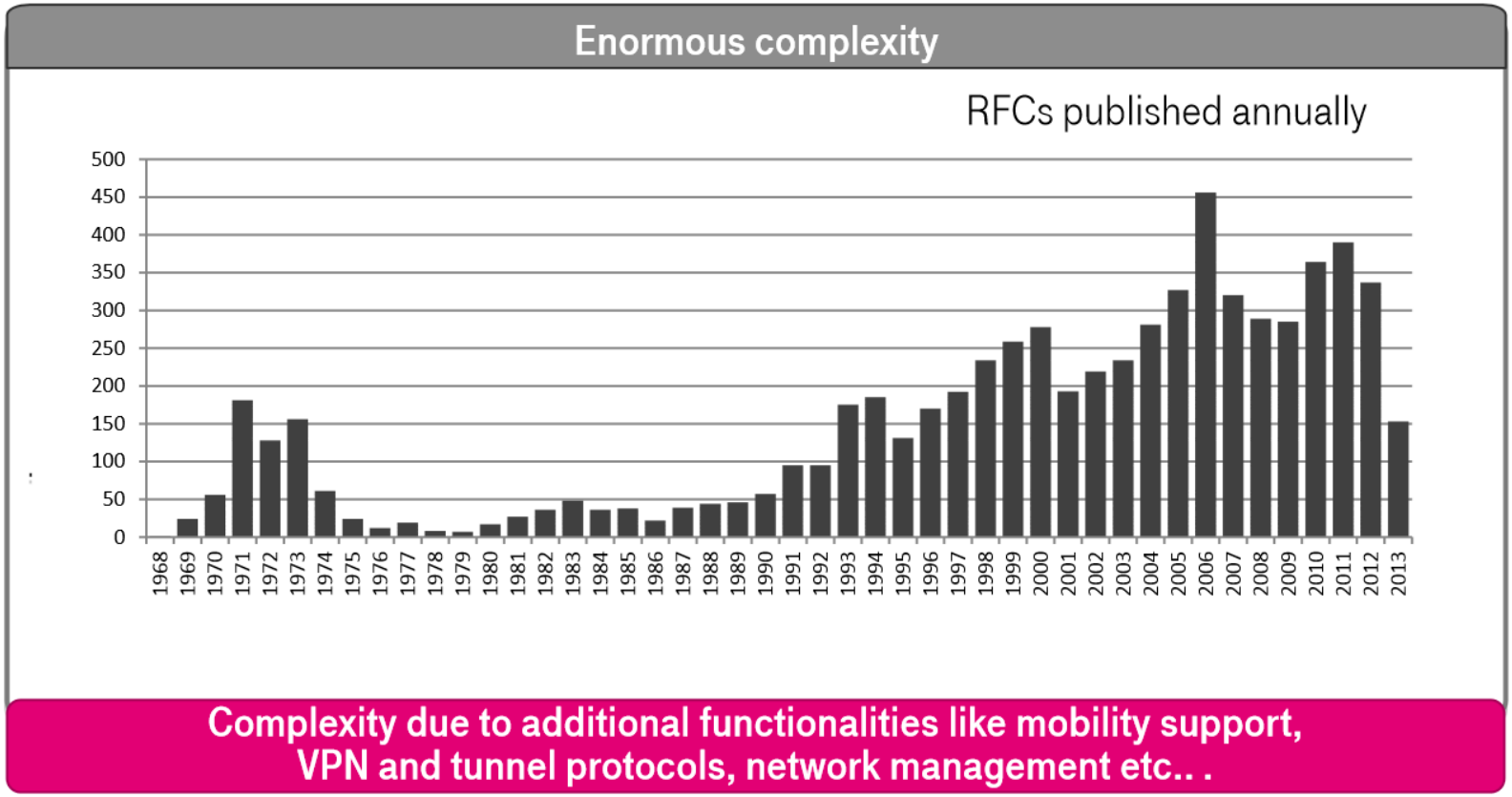
6. Complexity of managing large networks
7. Complexity of debugging
8. "Closedness" of hardware and software
9. Difficulty introducing new ideas
10. Inefficient use of hardware resources, energy efficiency



Network Protocols



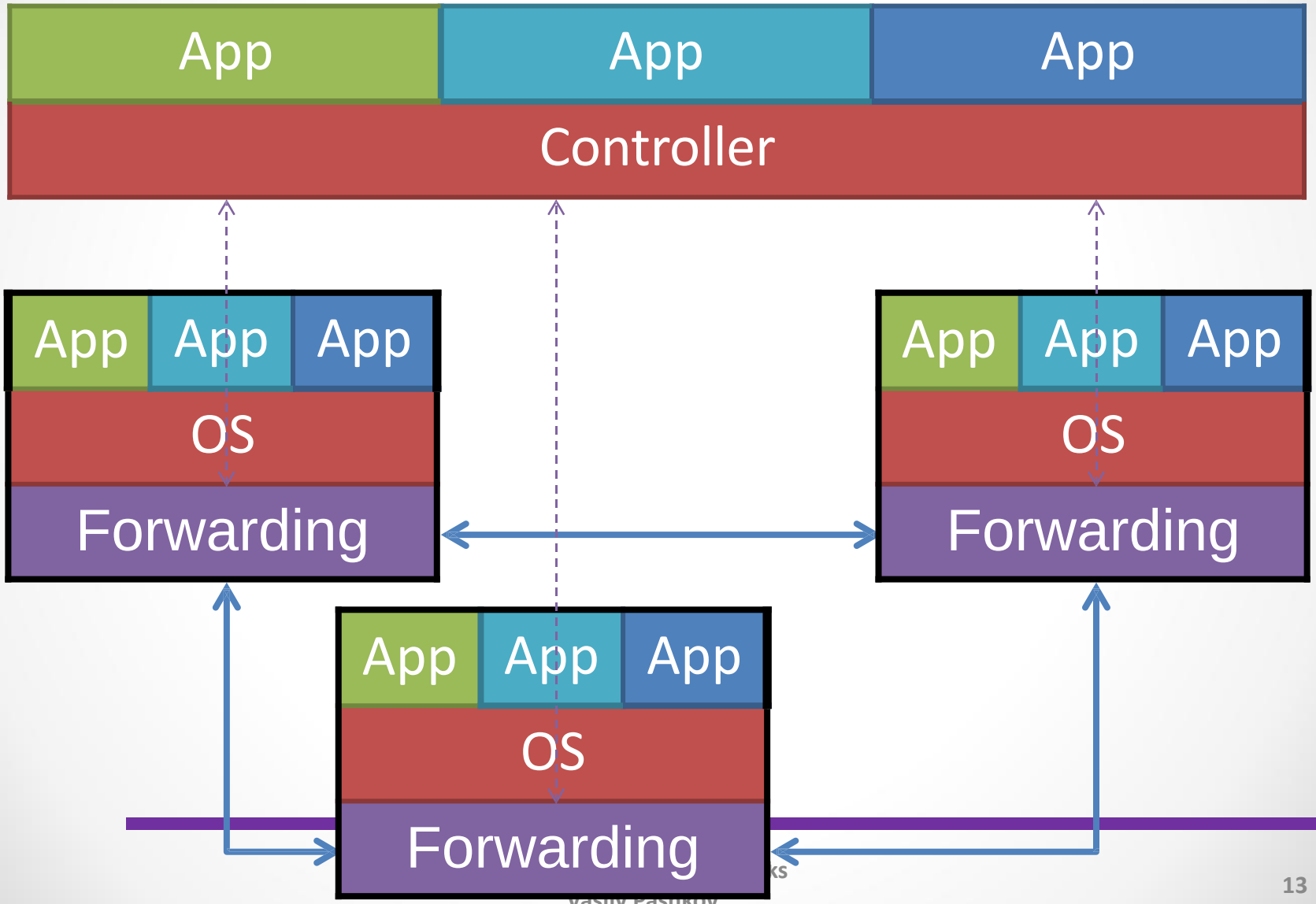
Enormous complexity



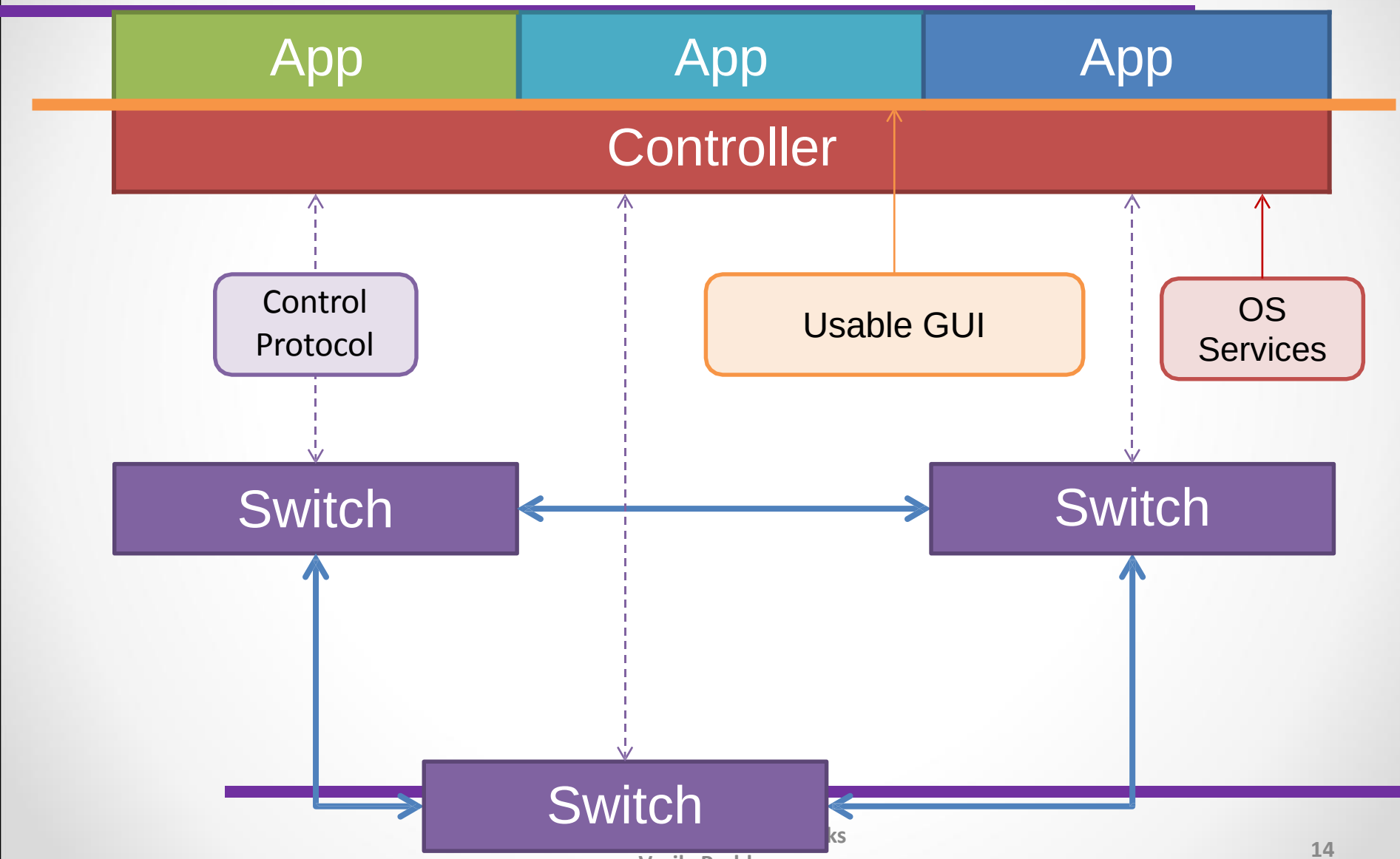
Source: http://www.telegeography.com/products/ip_transit/index.php; http://www.ietf.org/

2. Software-Defined Networks

Transition to SDN



SDN Architecture



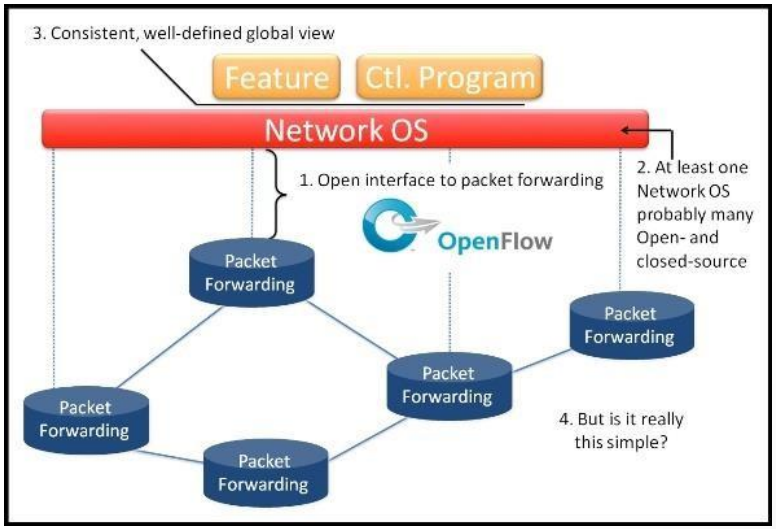
Basics of SDN

Implementations

Google

NTT Communications

1. Physical separation of the data transmission layer from the control layer of network devices
2. Logically centralized management
3. Programmability
4. Open unified management interface



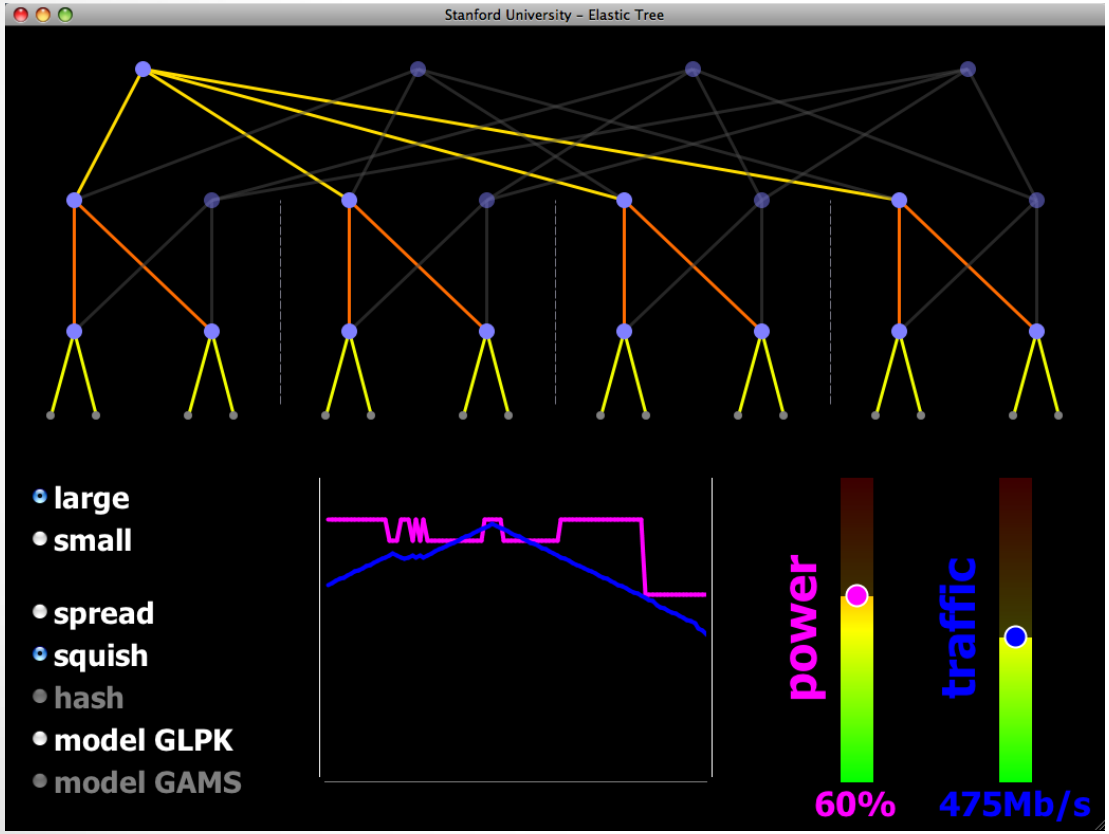
SDN Advantages

Implementations

- Increased flexibility and control speed
- Reduced Network Maintenance Costs (OPEX)
- Reducing the cost of equipment (CAPEX)
- Development of previously unavailable services

SDN Use cases

Goal: Reducing energy consumption in the data center



- Disable unused switches and links based on collected network information
- ElasticTree (Stanford): Reduce energy consumption by up to 60%
- Google Application

3. Network operating system (SDN controller)

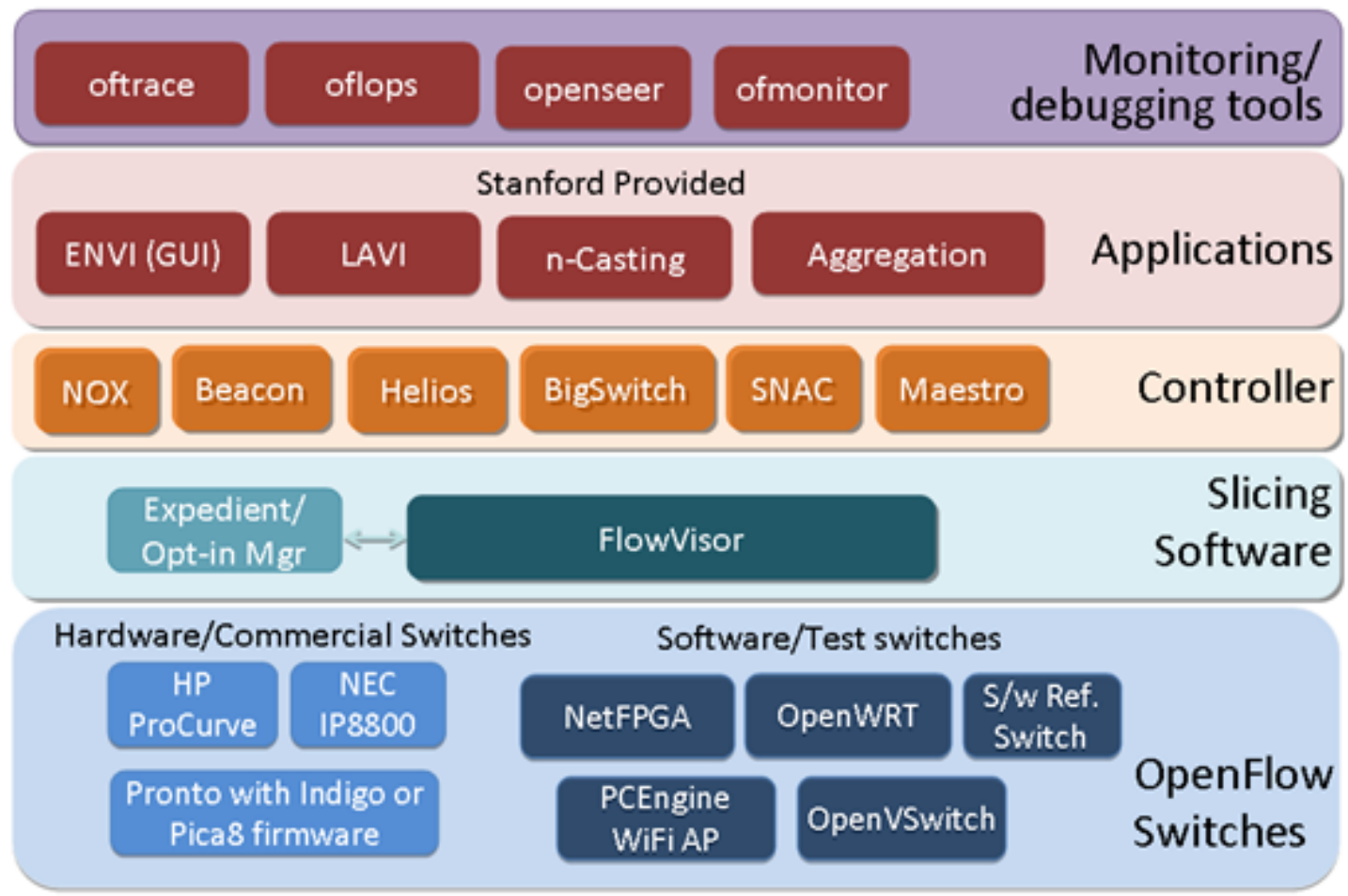
SDN controller requirements

- **Performance**
  - Throughput
    - events per second
  - Delay
    - us
- **Reliability and security**
  - 24/7
- **Programmability**
  - Functionality: applications and services
  - Programming interface

- Data center requires processing> 10M events per second
- Reactive controllers are more "sensitive"

4. SDN Stack

SDN/OpenFlow Stack



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Thanks for your attention!

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