

# OpenFlow and Open Networking

## An Introduction and Overview

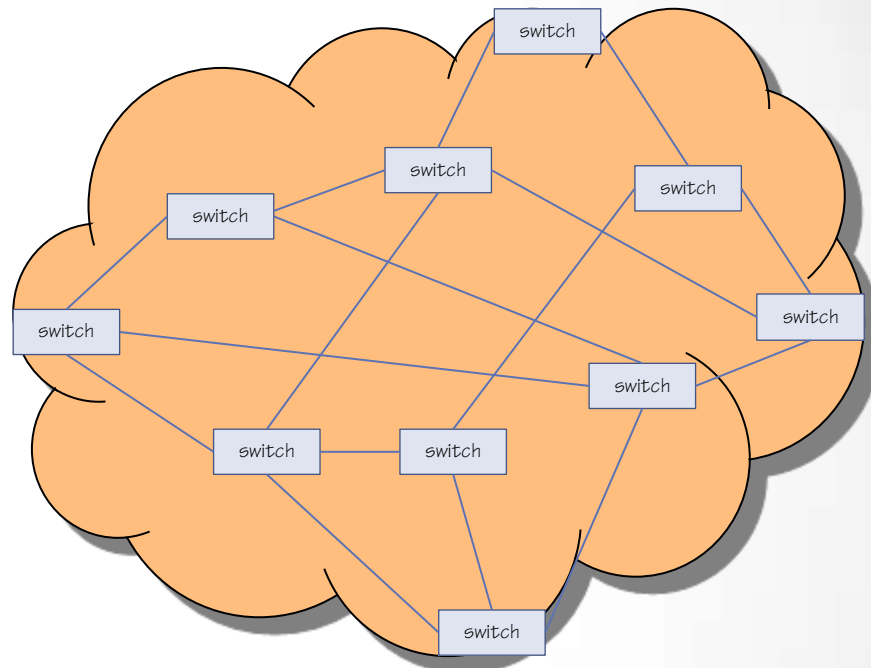
Peter Christy, IRG, [pchristy@irg-intl.com](mailto:pchristy@irg-intl.com)

February 2012

# What?:

## Modernizing the Control Plane

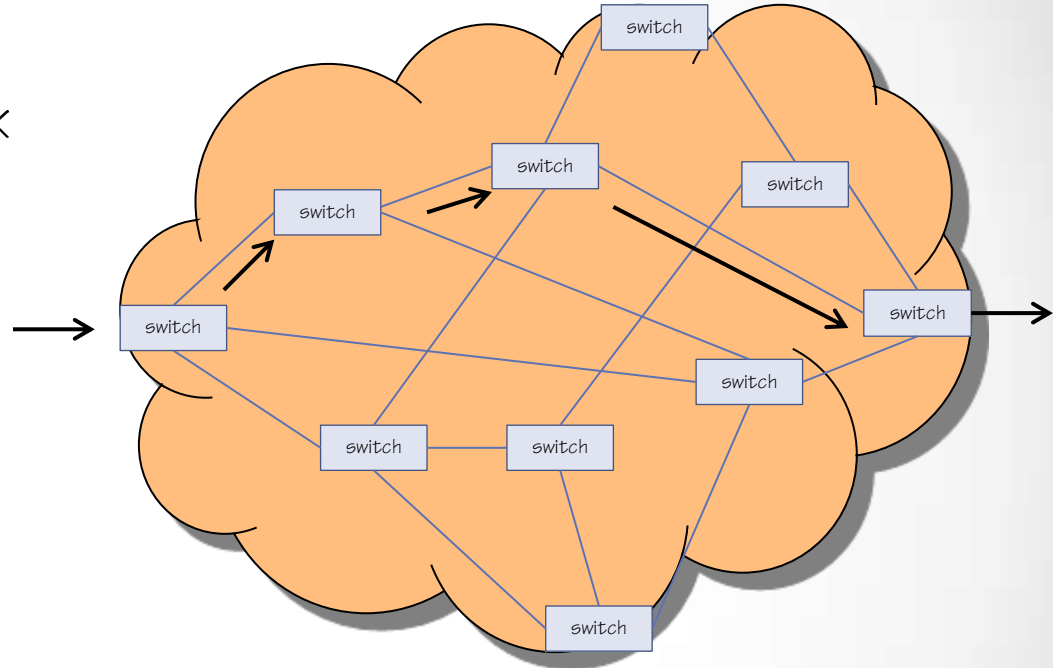
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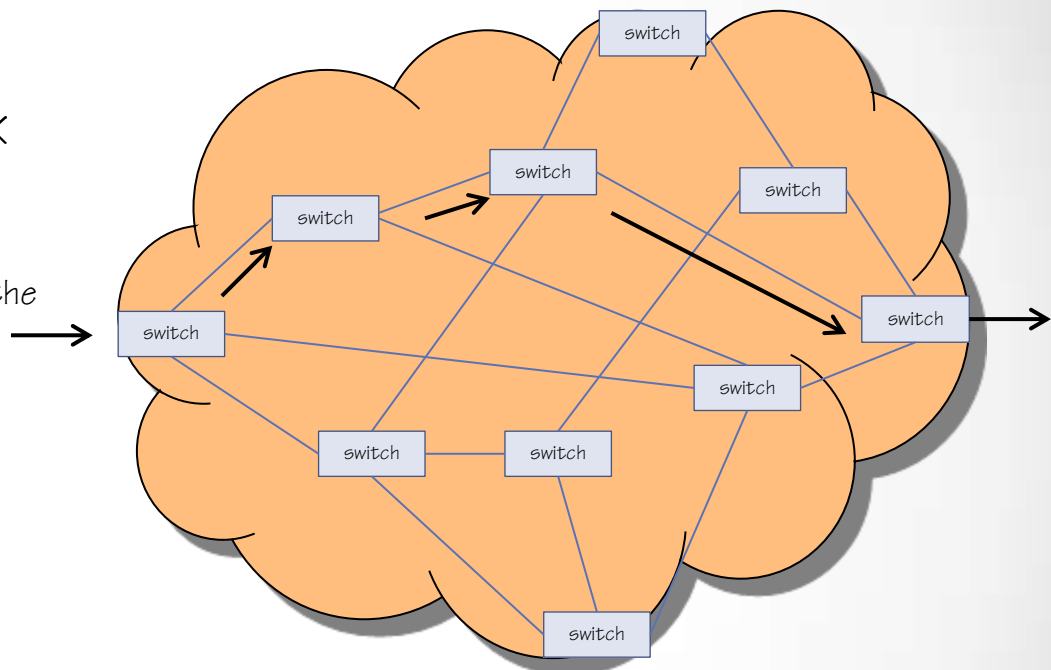
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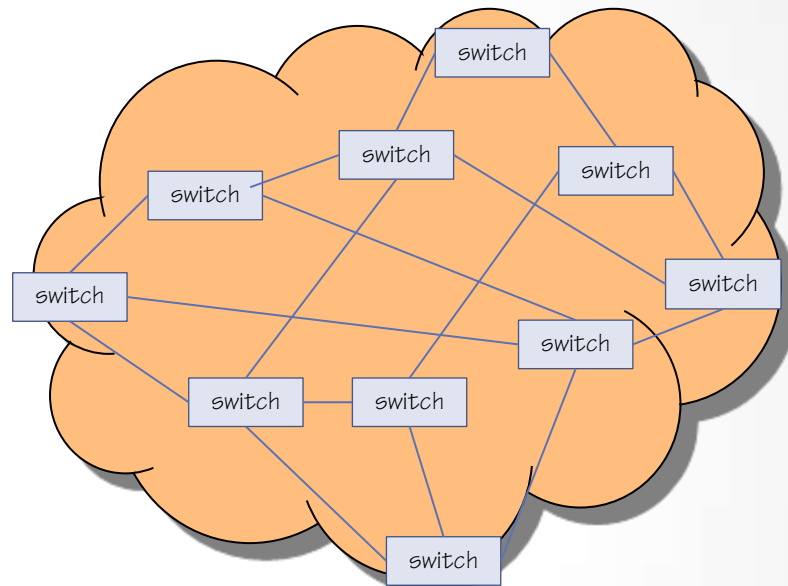
## Modernizing the Control Plane

- This is all about **modernizing the control plane** of a network
  - The **data plane** does the work of moving packets through the network
  - The **control plane** is the means by which the data plane is configured, and how exceptions are handled



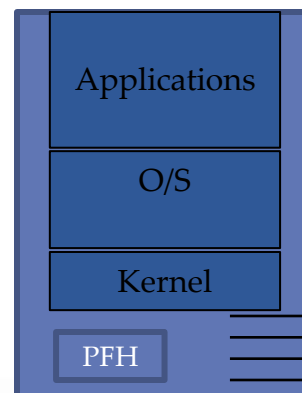
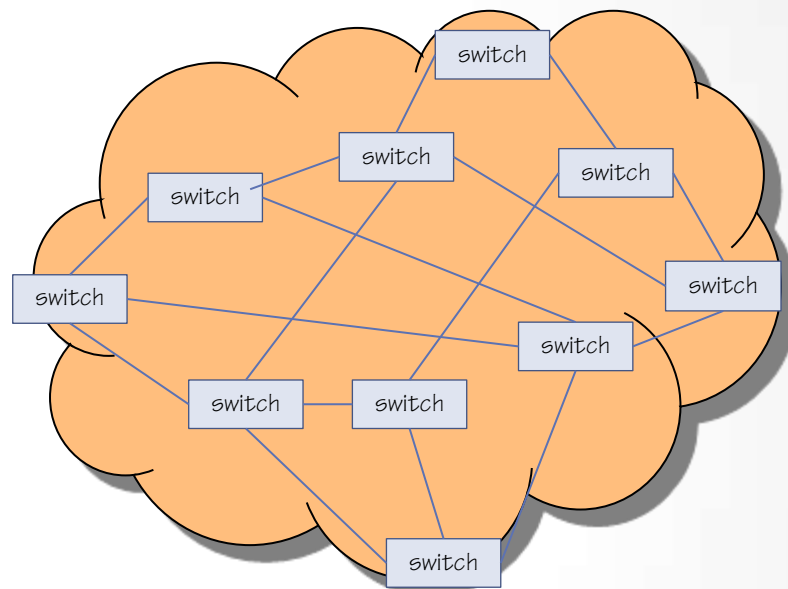
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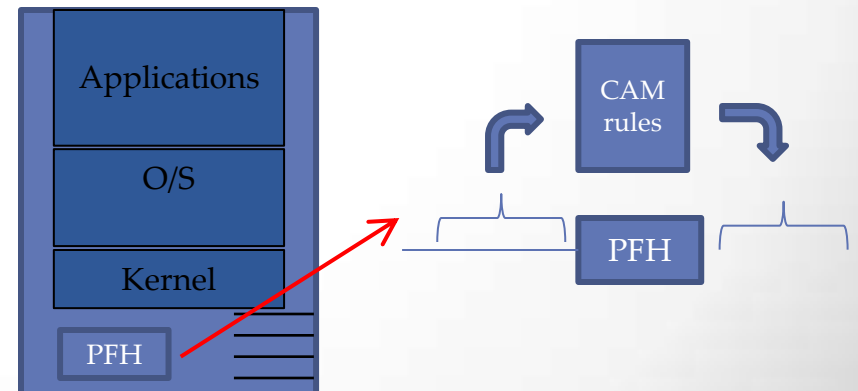
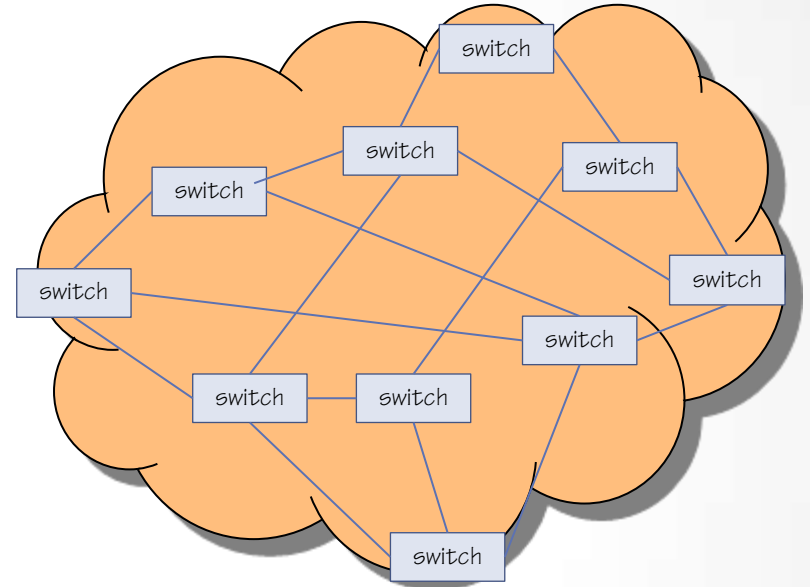
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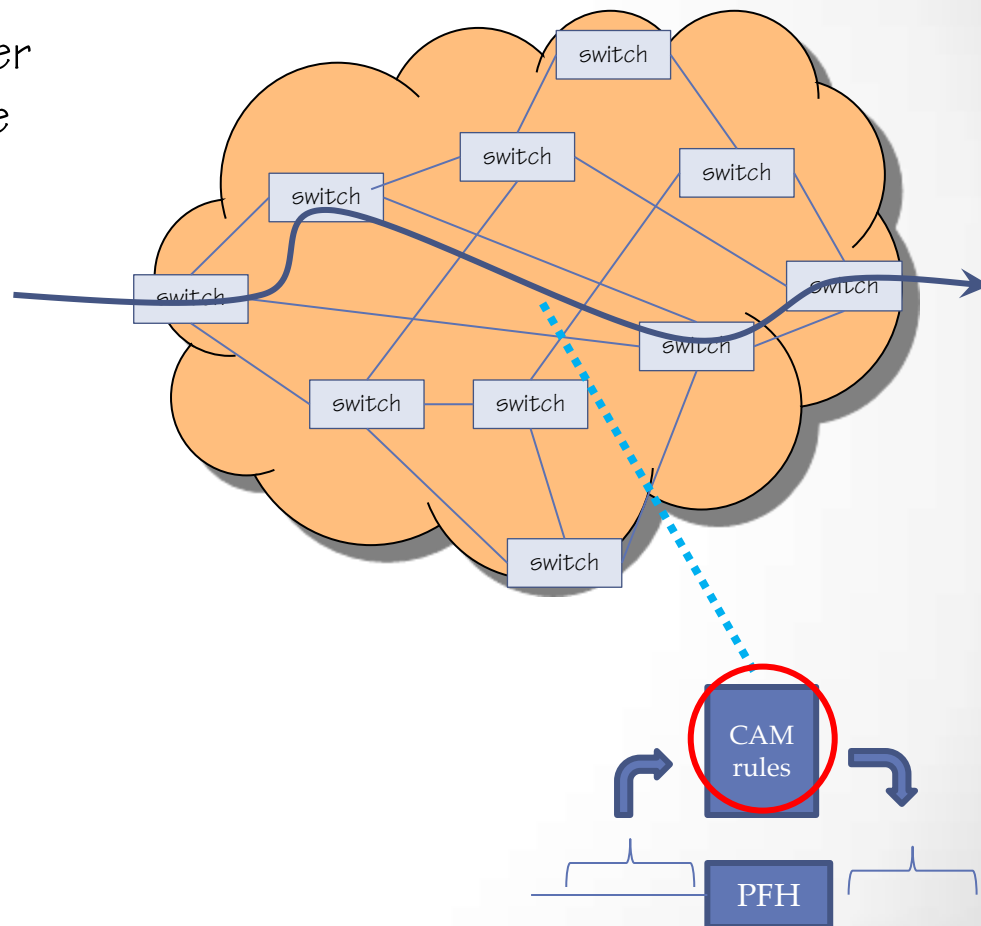
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- The packet forwarding hardware operates by examining the various header bits on the packet, consulting a set of rules stored in high speed associative memory (CAM) and if an applicable rule is found, using the rule data to select the output link, assign a queuing priority, and possibly rewrite some of the header bits.



# The Control Plane

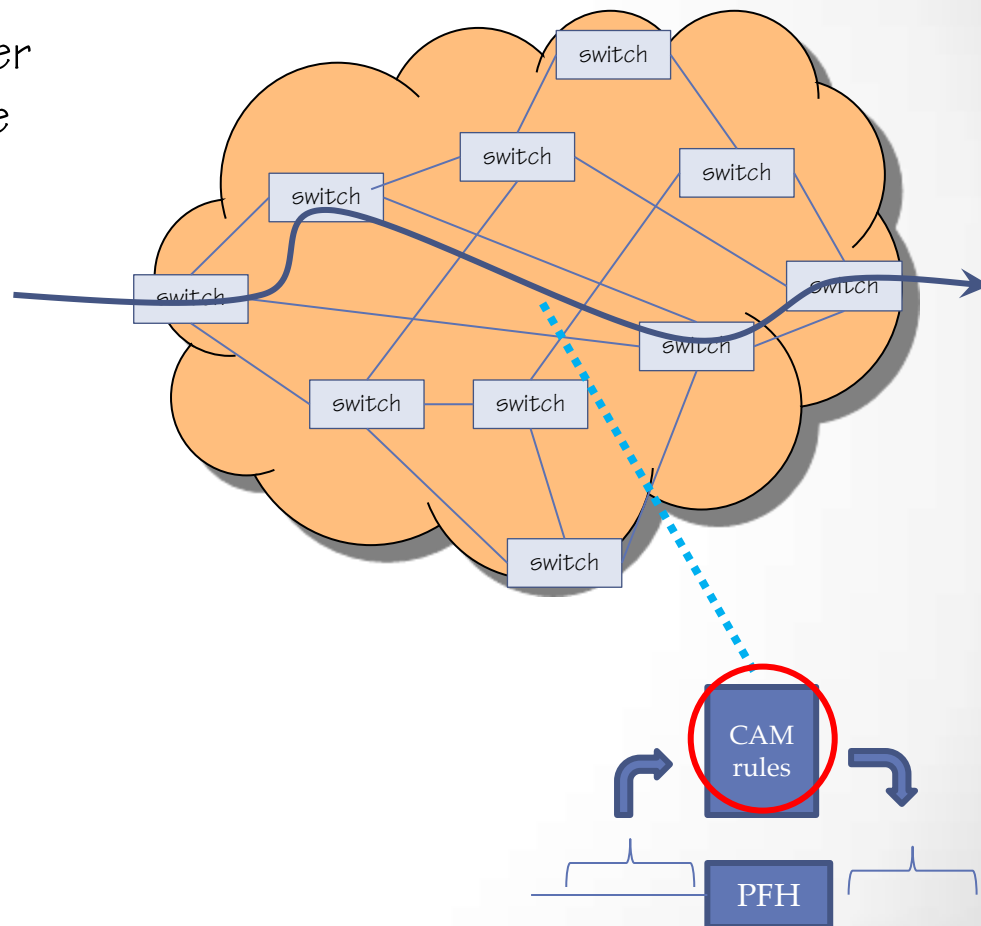
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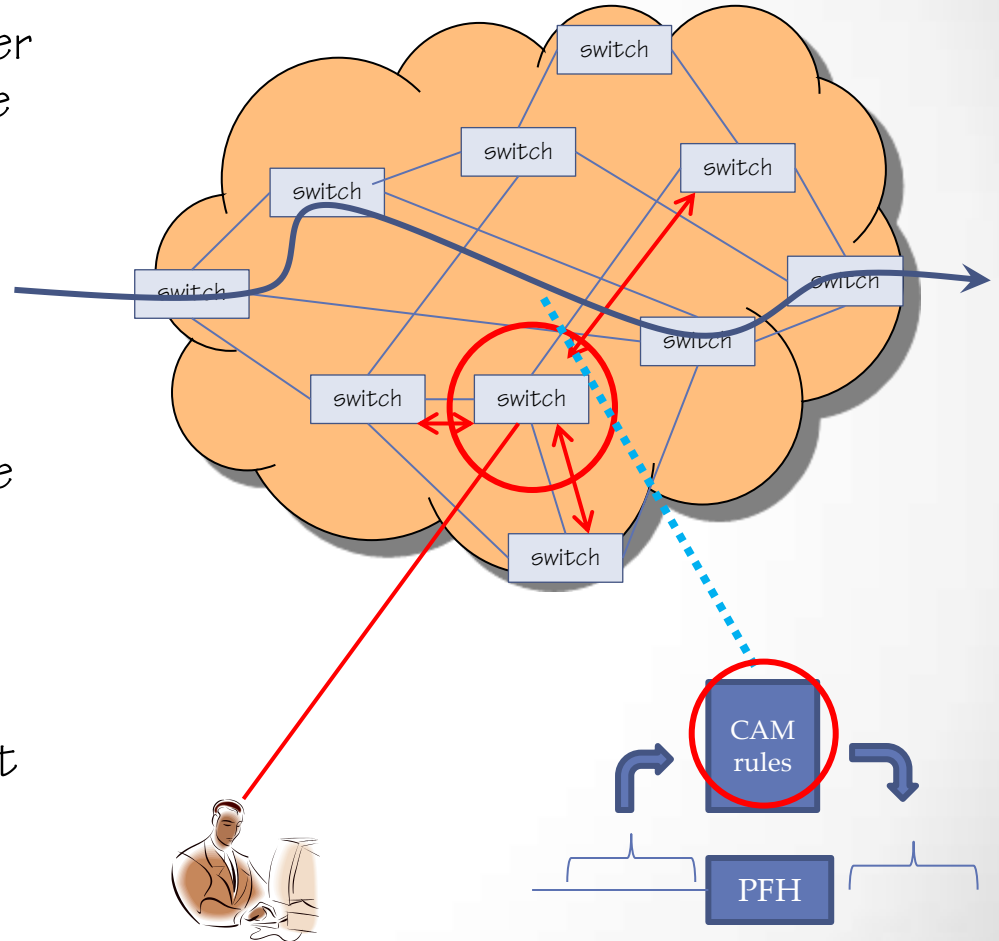
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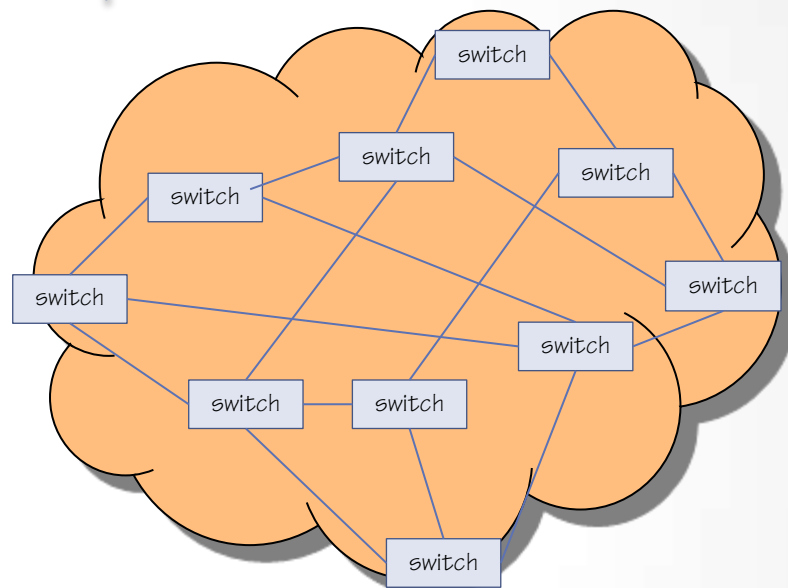
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- This can be done by command-line interactions with a network administrator (switch configuration) and then through the exchange of standardized control information with adjacent switches (e.g., routing protocols)



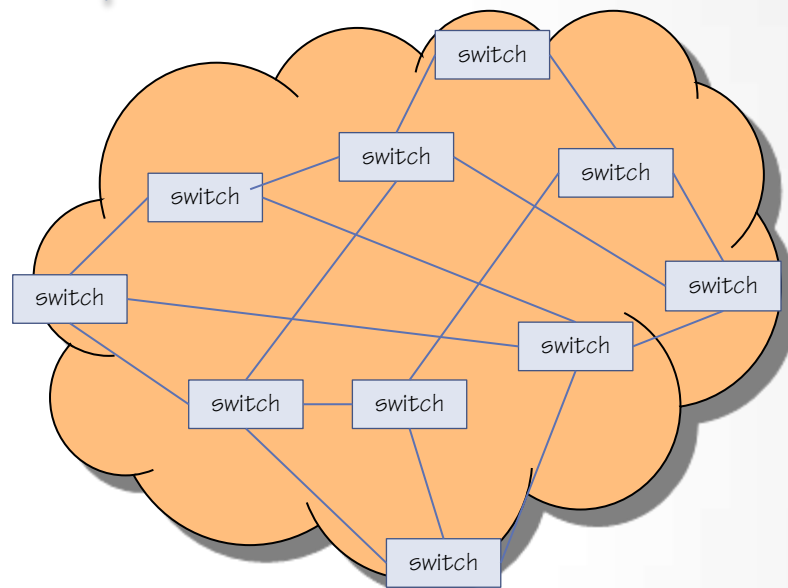
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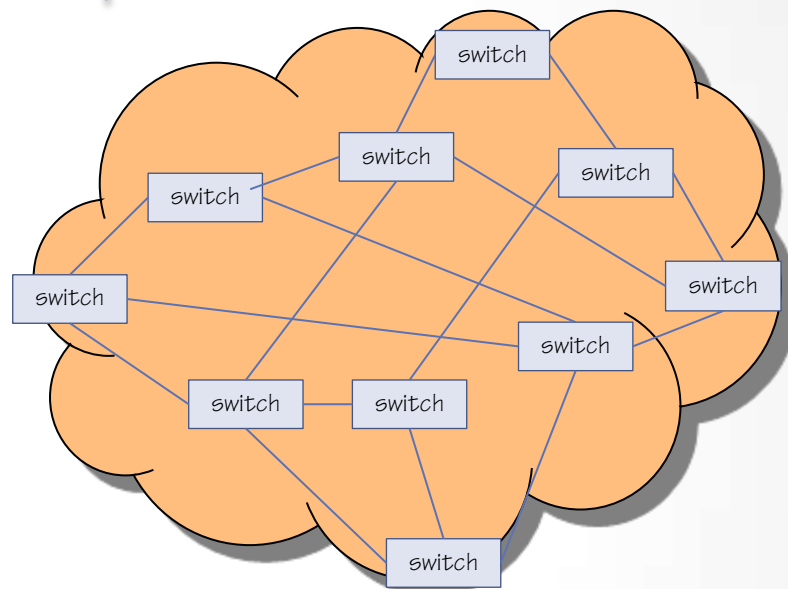
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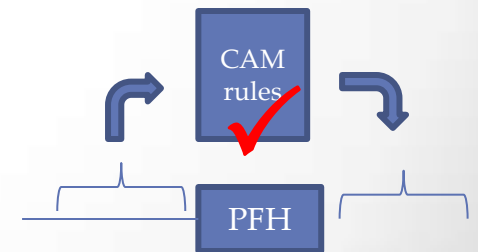
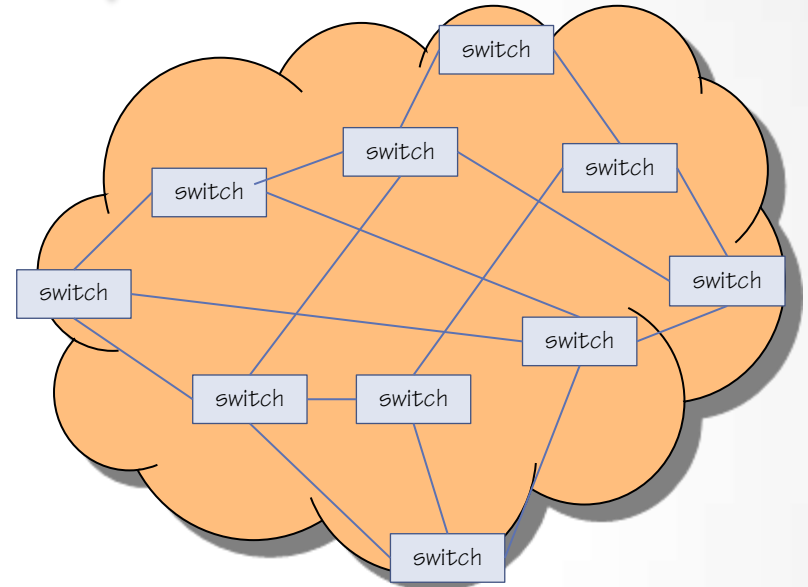
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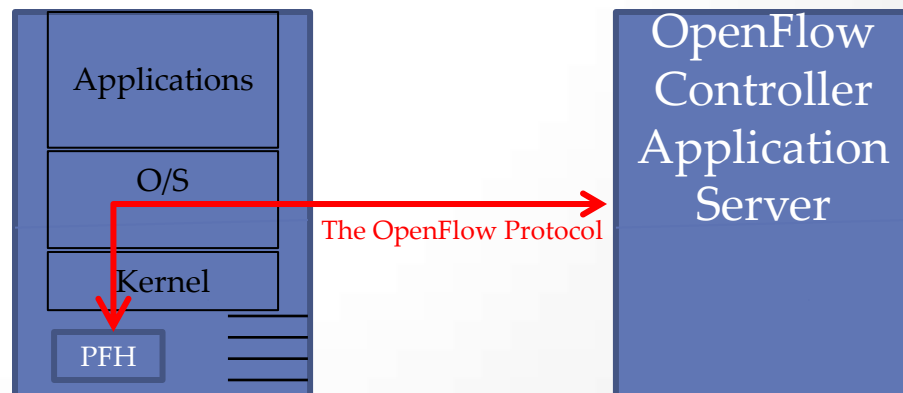
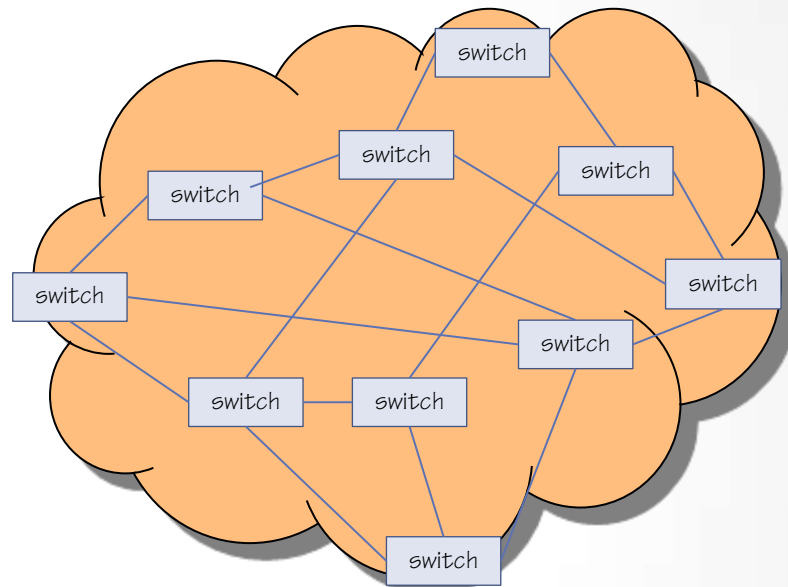
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- What about programming the PFH?
  - In contrast to the software designs, PFH hardware is all similar. What about directly programming the Packet Forwarding Hardware?



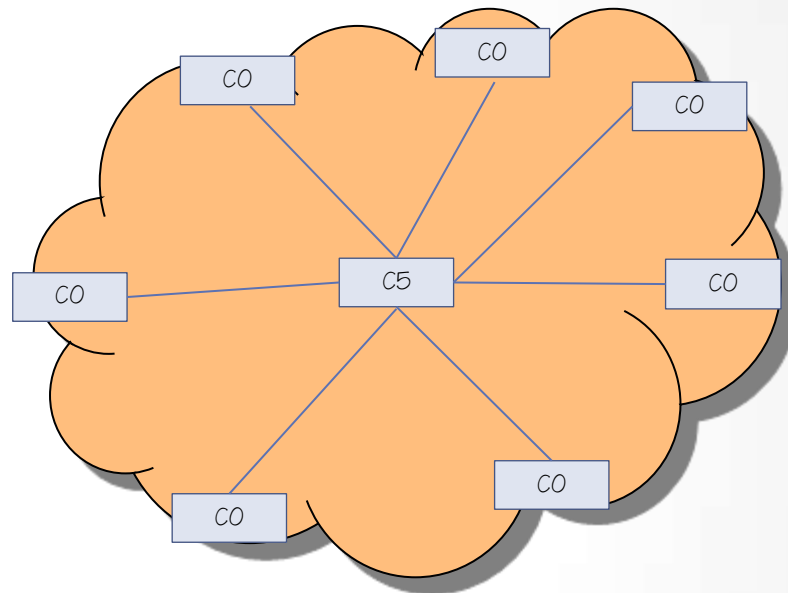
# OpenFlow: a PFH Control Protocol

- OpenFlow is a protocol by which the PFH hardware in a switch can be managed by software executing in a separate server, external to the switch, in a standardized way.



# Why Modernize?

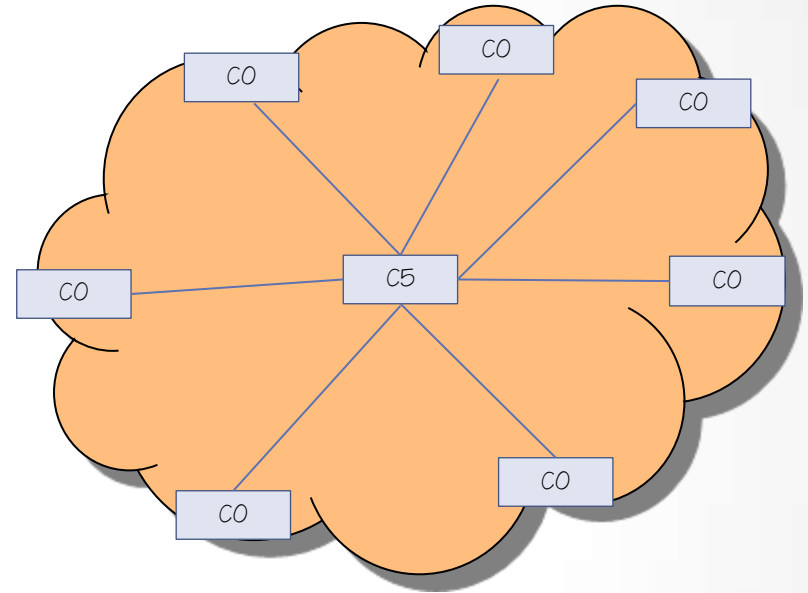
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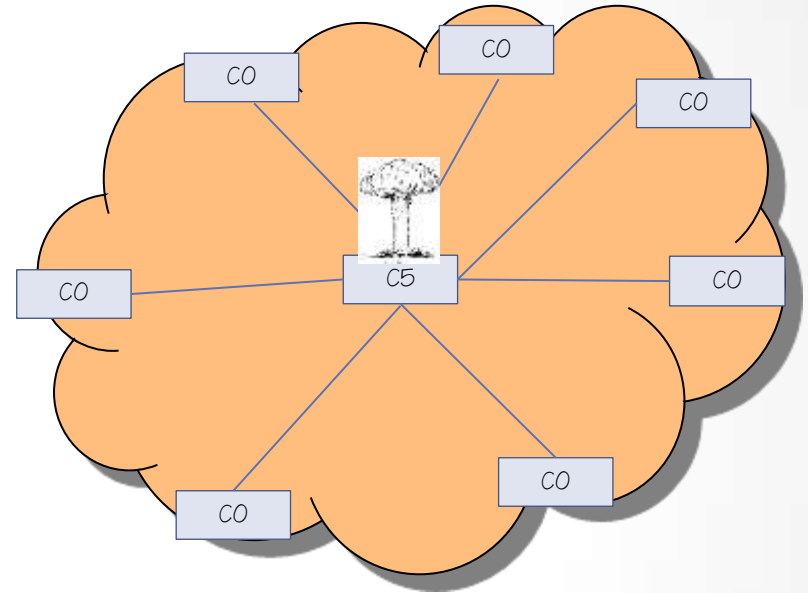
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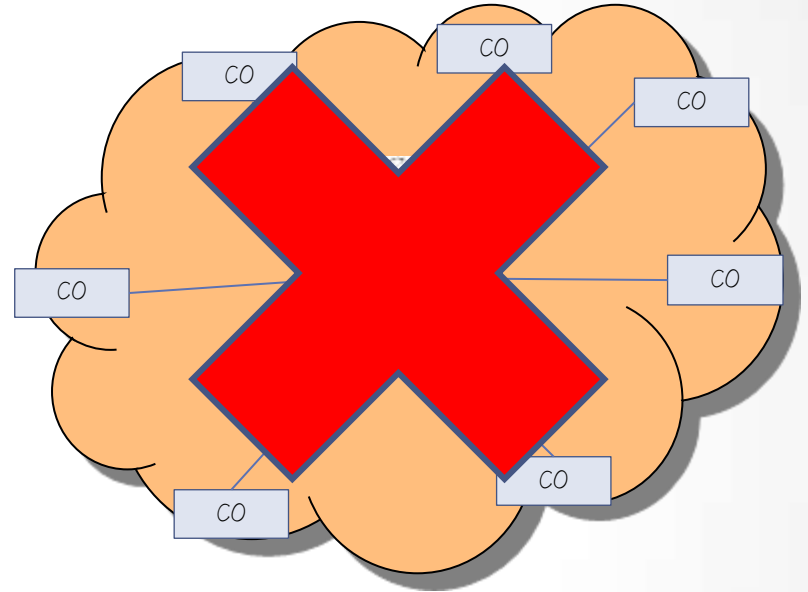
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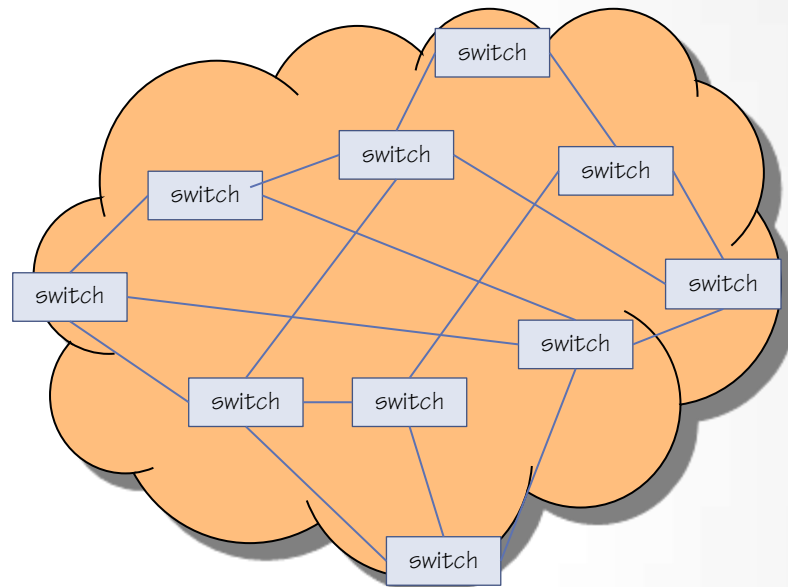
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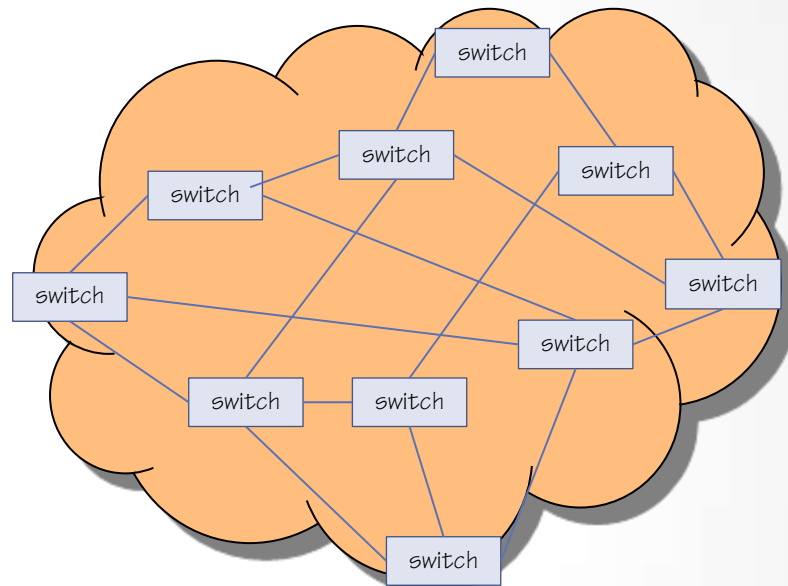
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- Packetized Voice Communications
  - Transform voice communications connections into sequences of packets of voice data.



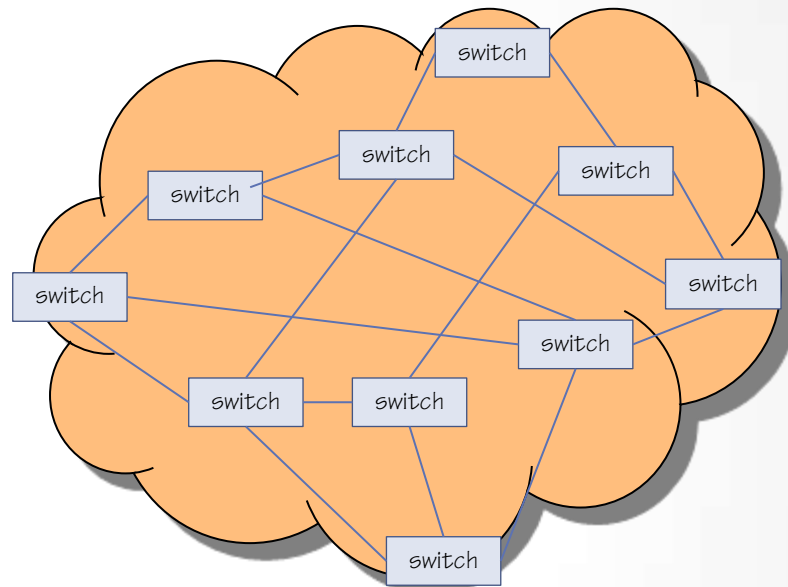
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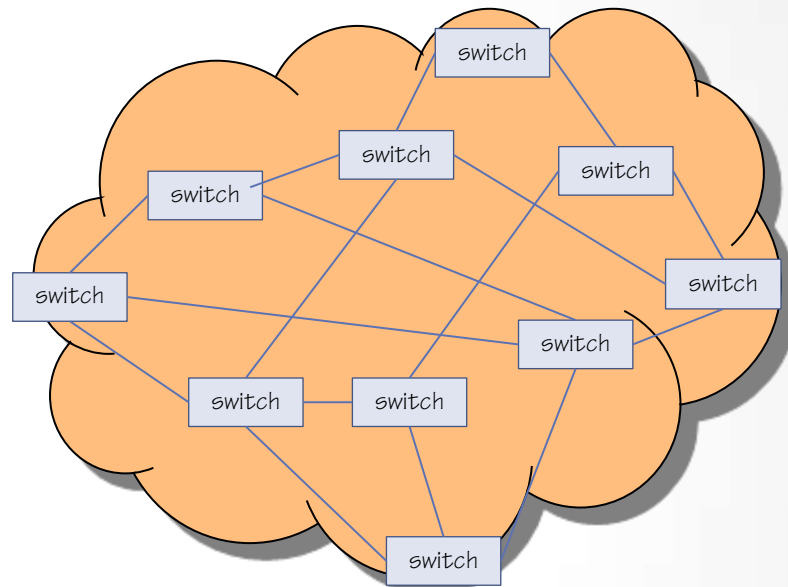
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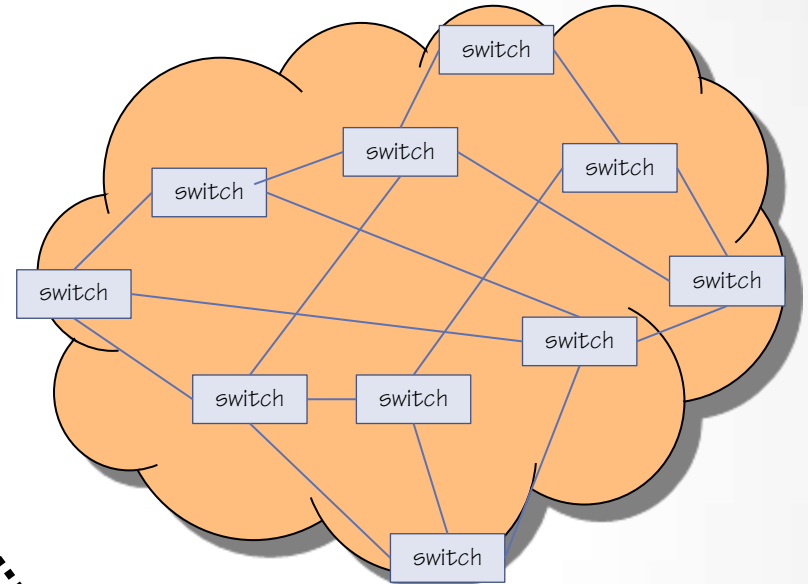
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the legacy Baran "survivability"  
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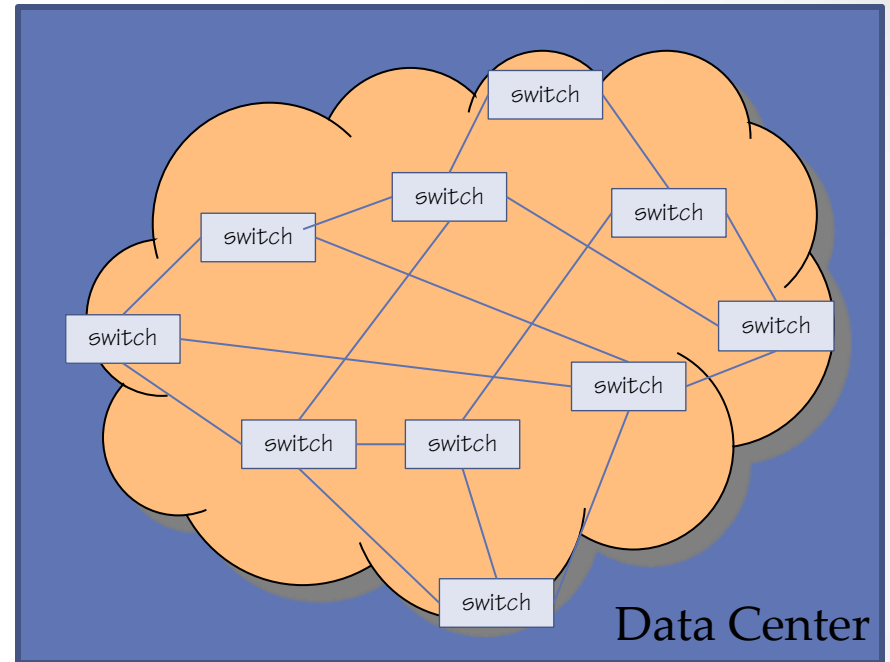


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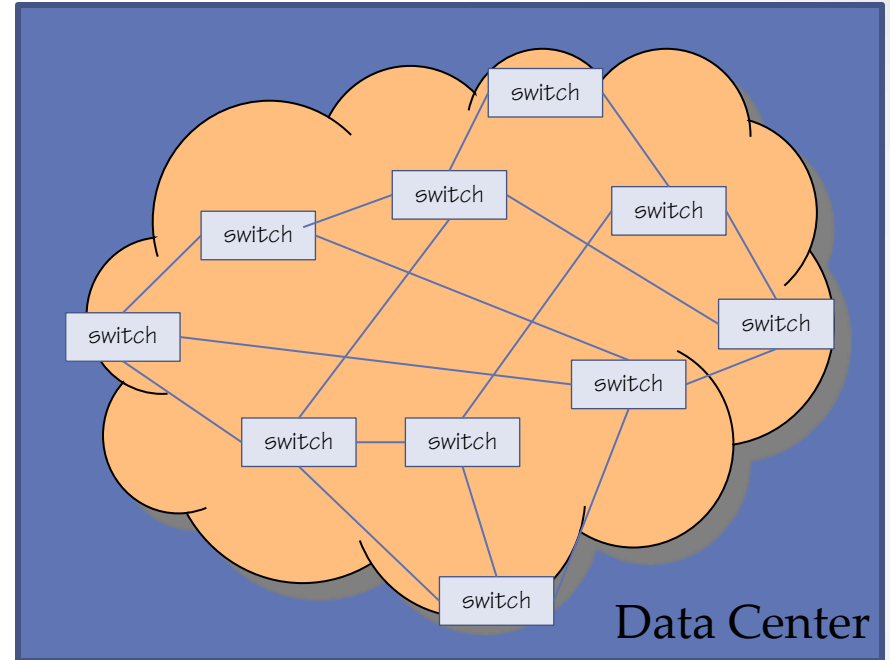
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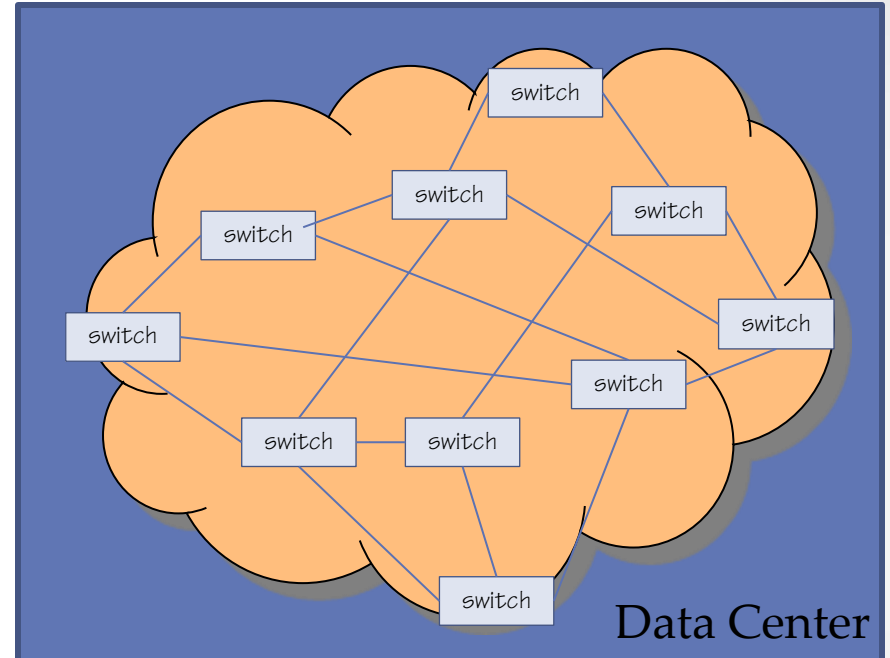
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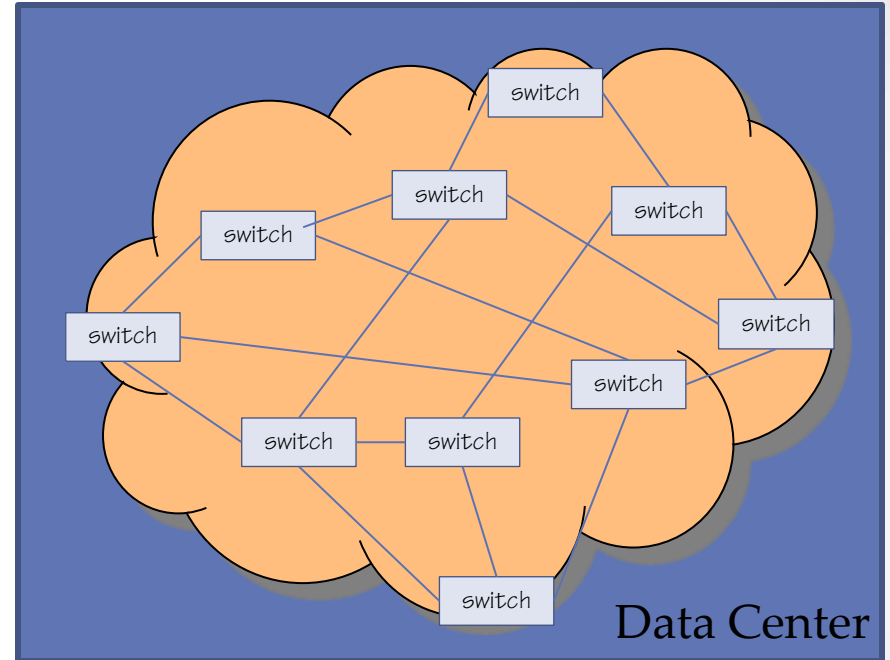
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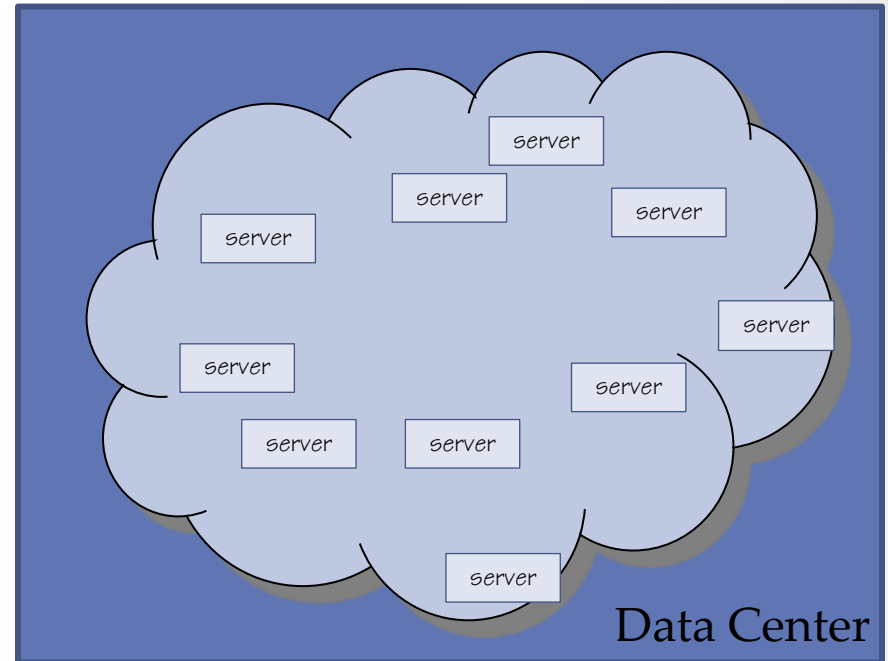
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- We want the network to operate as a coherent whole.
- Managing the network with the legacy “Baran” control plane architecture is really hard



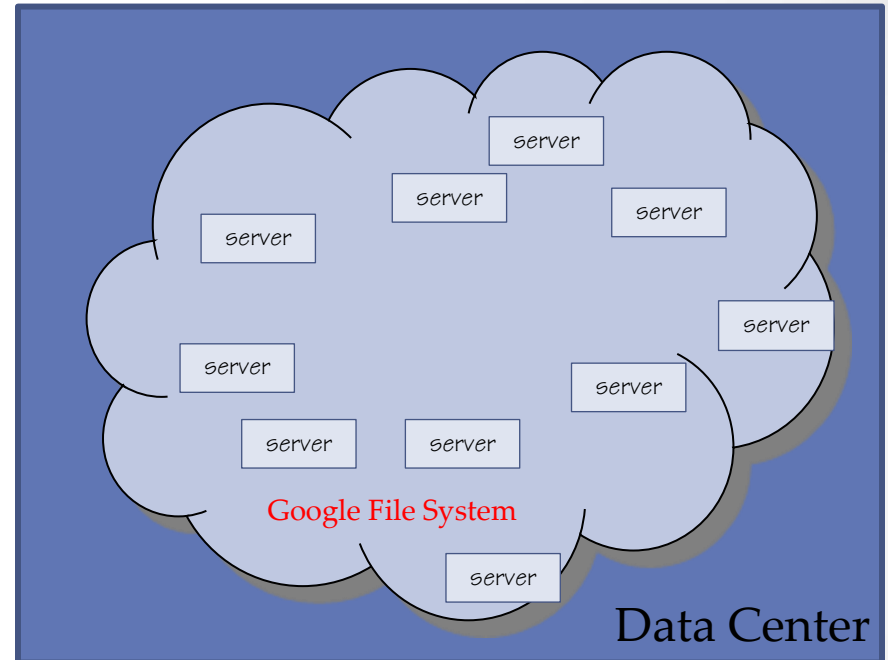
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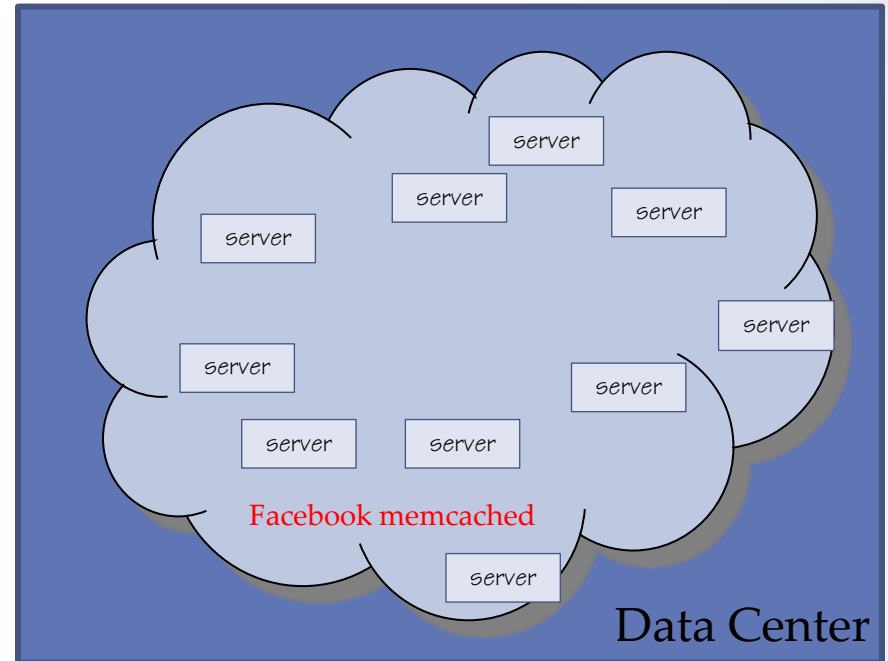
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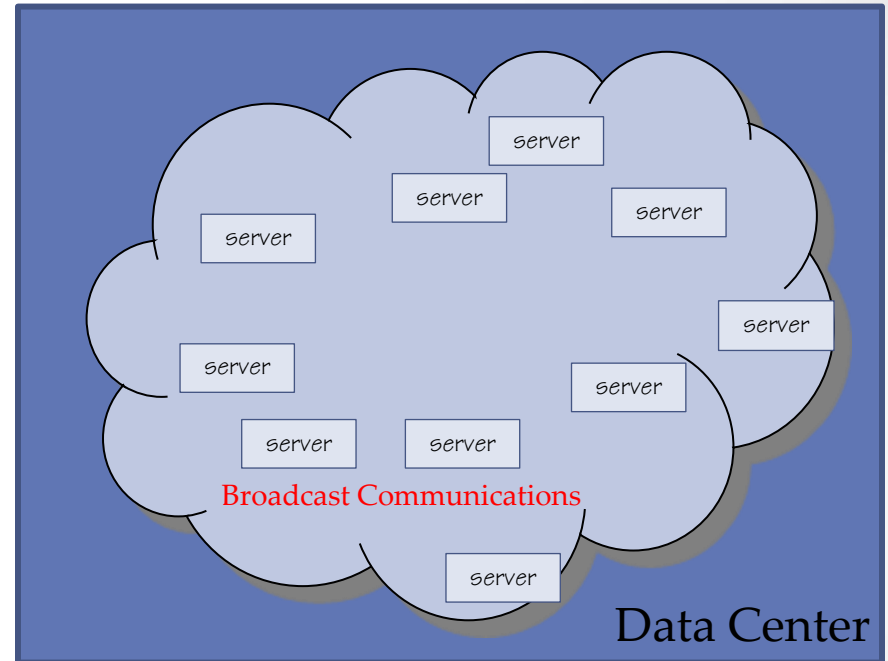
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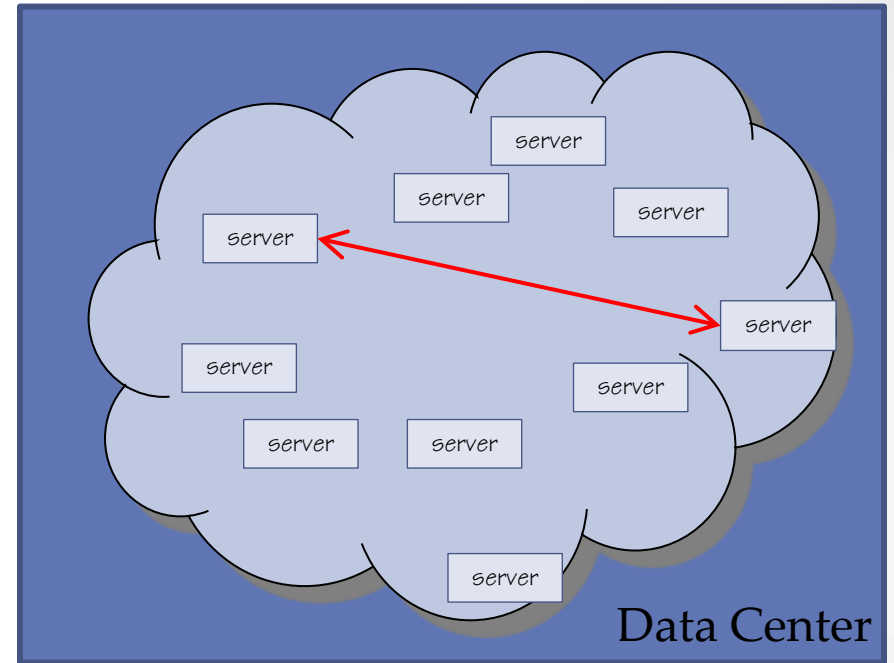
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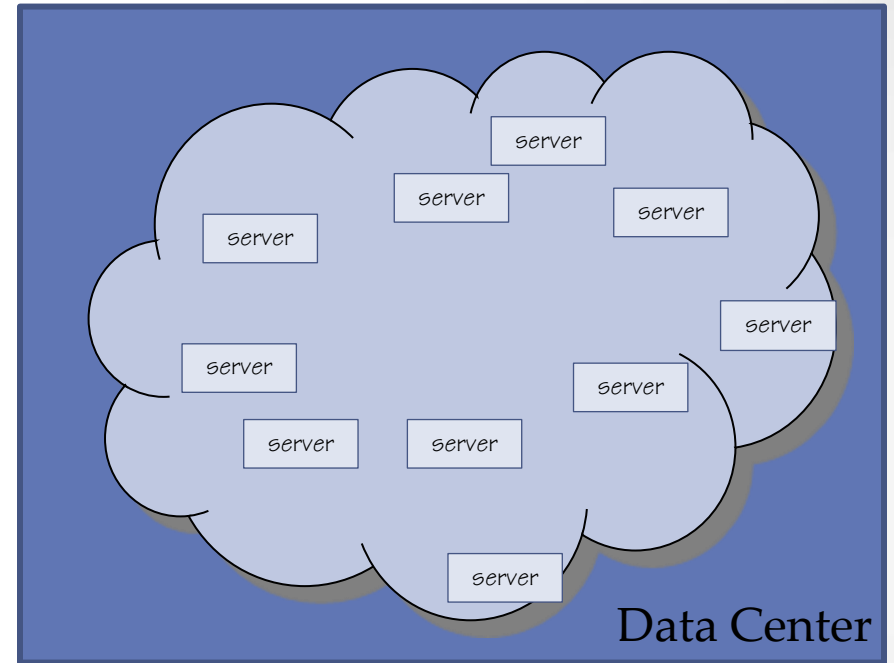
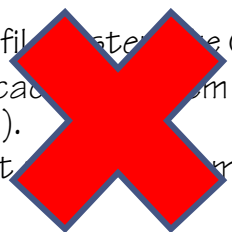
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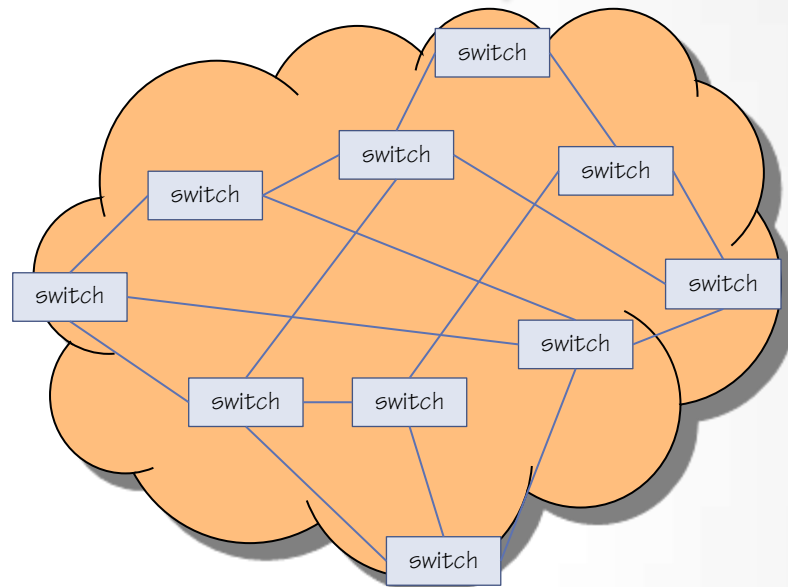
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- All of these are prohibited by a legacy control plane architecture that was created to maximize survivability.



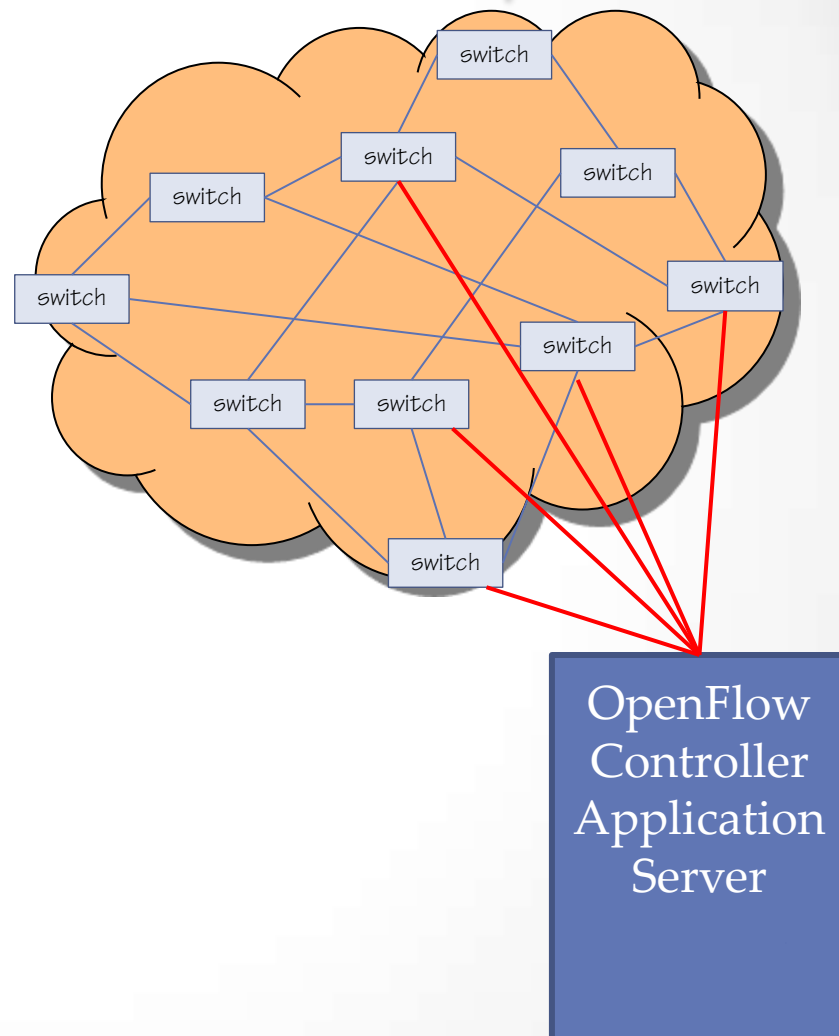
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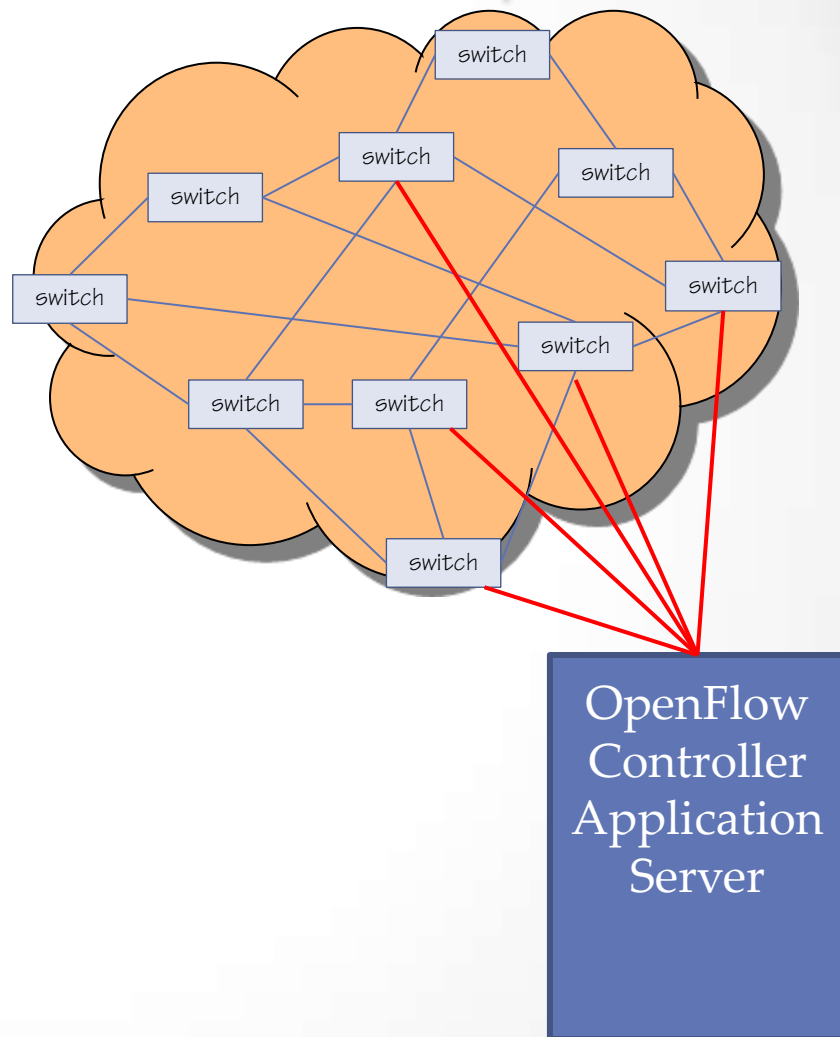
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- We implement the control plane in the OpenFlow controller (remember, it's just a server application)
- We do anything we want, no longer constrained by the survivability design architecture or by the internal software design of the switches



# What is a “Flow” Anyway?

- Ethernet networking is between the MAC addresses of the network interfaces on systems.
- IP networking assigns each system an IP number and then switches traffic based on the IP number throughout the internet until the final switch that knows the associated MAC address of the destination
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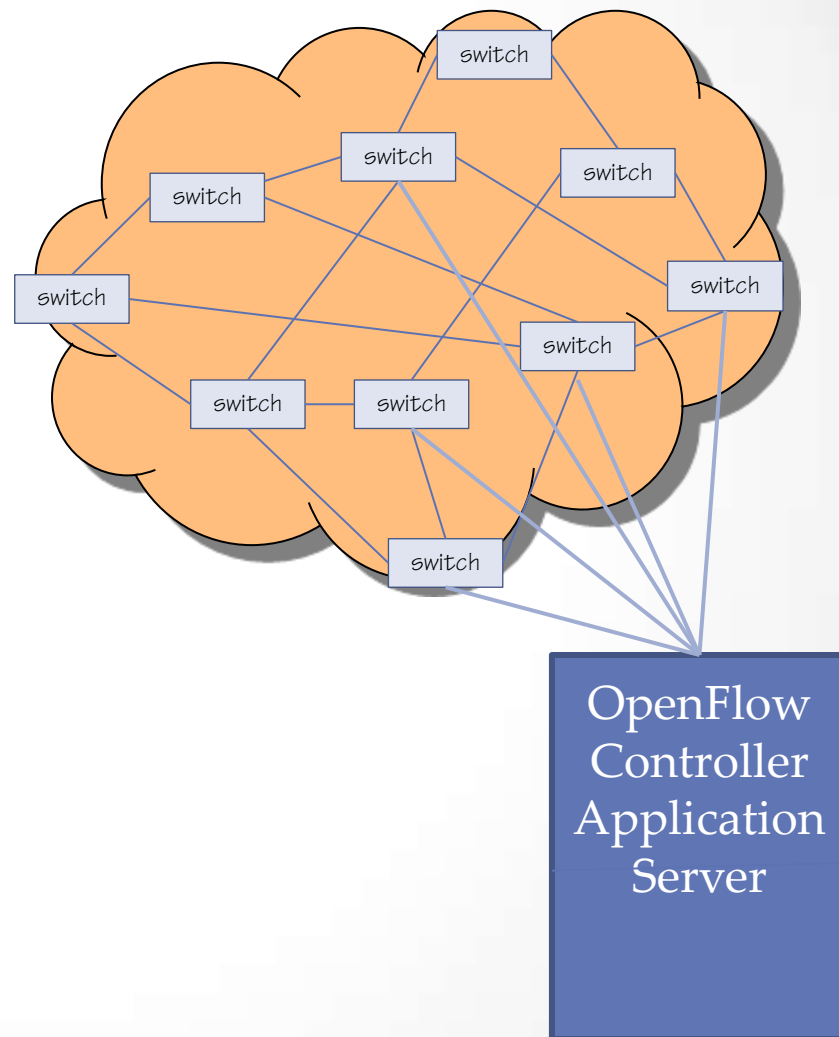
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- OpenFlow adopts flow-based processing but only within a single network. To the rest of the network it is still a conventional TCP/IP network.
- Being able to switch on an individual flow basis enable innovative ways of doing security (for example) but requires larger (more expensive) CAM's in the PFH, and requires fast controller response to a new flow.

# OpenFlow for Research

- Modify an existing network (e.g., the Stanford campus network) so that the switches support OpenFlow.
- Create a research control plane
- Gets better if “Hybrid” switch operation is possible
  - Let the existing flows be managed by the legacy network
  - Let the OpenFlow controller manage the new “research” flows



# OpenFlow Beyond Research

- Network management requirements for virtualized, cloud data centers
  - Fast provisioning of virtual networks
- Impact of the edge “switch” now being in the hypervisor
  - A modern control plane can be implemented within the Virtual Switch that is part of the hypervisor
- Desire for more flexible asset use in network service providers
  - Move as much “network” processing as possible (e.g., firewall, VPN termination) to execute as virtual machine on conventional servers (less expensive CPU, use of shared resources).
  - Be able to provision these now virtualized services on-demand without having to speculatively provision features in a network device
- Desire to speed up innovation in networking broadly
- Cost minimization and use of common processor resources in very large web properties

# A Radical Thought: SDN without OpenFlow!

- The primary SDN goal is to modernize the control plane in order to solve real, vexing network management issues (like creating virtual networks).
- Juniper QFabric:
  - Clearly SDN (a modernized control plane)
  - “Controller” distributed to each Top of Rack Switch; communications between controller and PFH would not use OF.
- Nicira:
  - Designed for building virtual networks in Cloud systems based on a hypervisor.
  - The switch is a vSwitch (see Nicira’s contribution to the Open vSwitch effort)
  - The controller is (I think) distributed to each virtual server cluster.
  - I don’t think OF is used to talk to the vSwitches in the cluster.
- Contexstream
  - Building SDN’s for Verizon and Comcast
  - The switching elements are VM’s that use an interesting distributed-hash algorithm
  - Clearly a form of SDN, but no OF
- SDN Controllers
  - An interesting and challenging distributed system problem with tradeoffs
  - OF is great for research and for limited adaptation to existing networks (e.g., NEC).
  - Direct controller / PFH interface is much higher performance (seems important for doing pure flow-based processing)

# Current status

- Openflow.org -> ONF (upcoming 2<sup>nd</sup> ONF Summit at Stanford)
- Continuing work
  - on OF in conjunction with controller implementation
  - on the best way to create the data plane fabric
  - in virtual switch technology and “overlay” networks
- Some interesting issues
  - No enterprise “killer apps” yet
  - Market insertion in general is a challenge
  - Transfer of value from hardware to software

# Follow up

- [pchristy@irg-intl.com](mailto:pchristy@irg-intl.com)
- Thanks!