



Software Defined Networking

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In this course, you will learn about software defined networking and how it is changing the way communications networks are managed, maintained, and secured.

Module 1: History of SDN

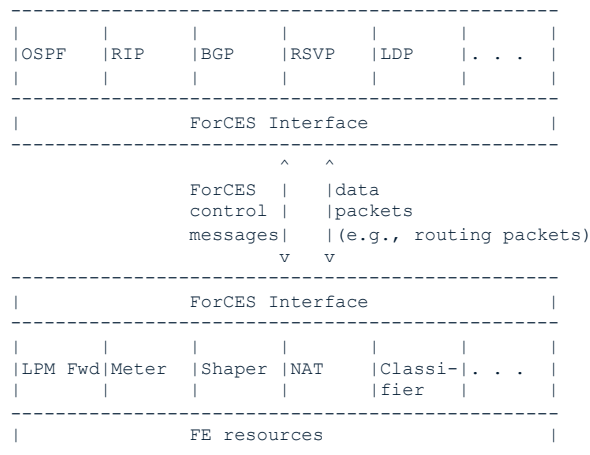
- ⦿ This Lesson: *Control of Packet-Switched Networks*
- ⦿ Why separate control?
- ⦿ How to control a packet-switched network?
 - **Separate control channel:** FORCES (2003)
 - **In-band protocols:** Routing Control Platform (2004)
 - **Open hardware:** Ethane (2007), OpenFlow (2008)

Why Separate Control?

- ◎ **More rapid innovation:** Control logic is not tied to hardware
- ◎ **Network-wide view:** Easier to infer (and reason about) network behavior
- ◎ **More flexibility:** Can introduce new services more easily

Custom Control: IETF FORCES (2003)

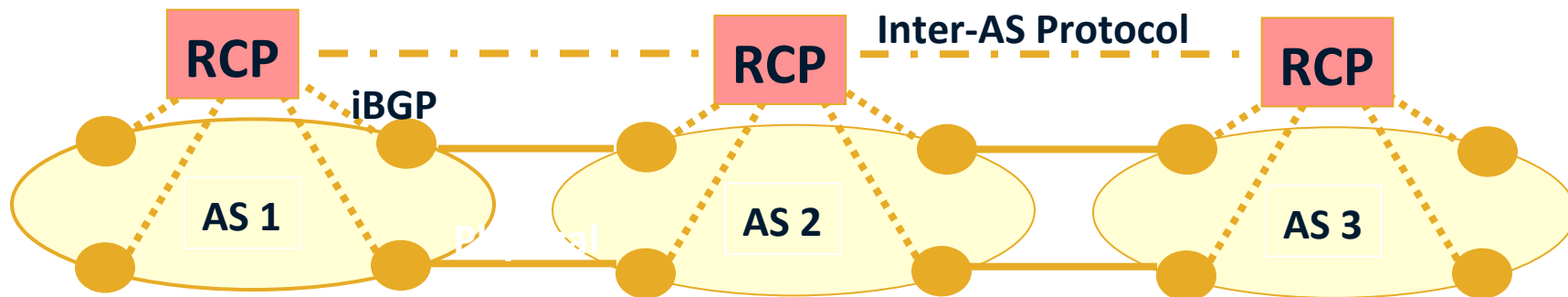
- First RFC in 2003, three implementations
- Protocols for multiple control elements (CE) and forwarding elements (FE)



Problem: Requires standardization, adoption, deployment of new hardware (same problem observed by previous work!)

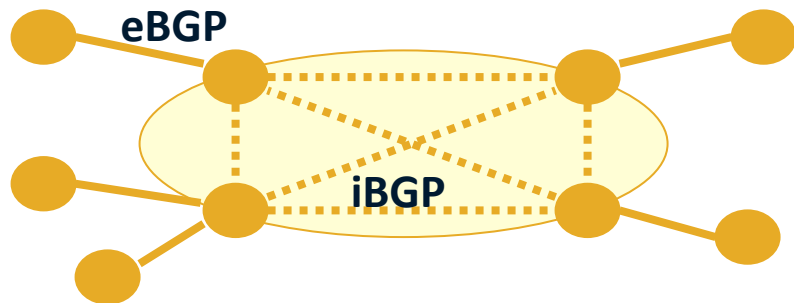
Routing Control Platform (2004)

- Computes routes on behalf of routers
- Uses existing routing protocol (BGP) to communicate routes to routers

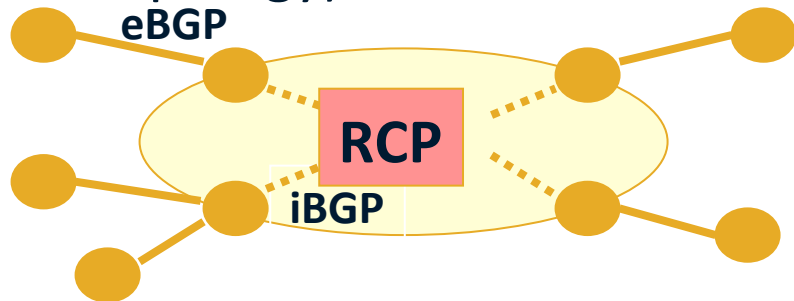


Using In-Band Protocols for Control

Before: conventional iBGP



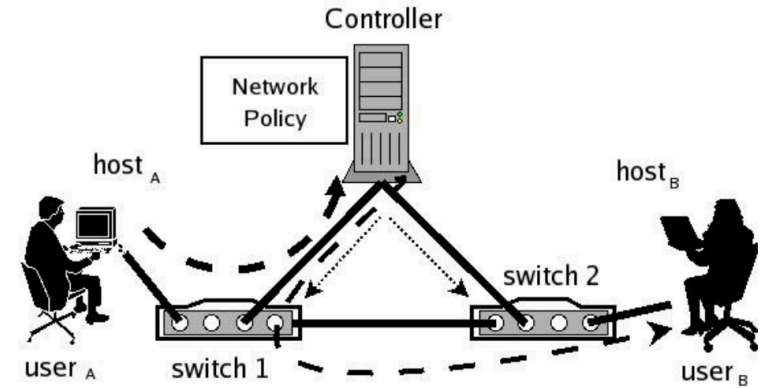
After: RCP gets “best” iBGP routes
(and IGP topology)



Problem: Control is constrained by what existing protocols can support.

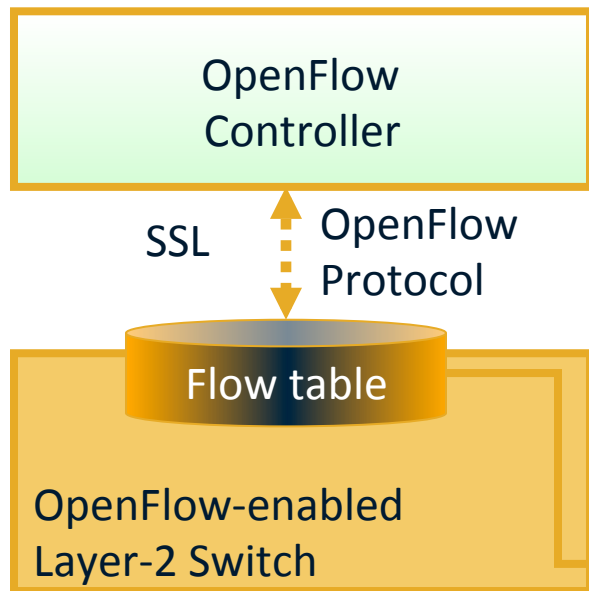
Customized Hardware: Ethane (2007)

- ⦿ Network architecture for the enterprise
 - Direct enforcement of a single, fine-grained network policy
- ⦿ Domain controller computes flow table entries based on access control policies
- ⦿ **Custom switches:** OpenWrt, NetFPGA, Linux



Problem: Requires custom switches that support Ethane.

Open Hardware: OpenFlow (2008)



- Layer two forwarding table (flow table entries)
- Switch exposes flow table through simple OpenFlow protocol
 - Keep it simple
 - Vendor can keep platform closed, but expose an open interface to control forwarding table

Matches subsets of packet header fields

Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport
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What have we learned about control?

- Control and data plane should be decoupled
 - Vertically integrated switches make introducing new control planes difficult (*FORCES*)
- Using existing protocols makes deployment easier, but constrains what can be done (*RCP*)
- Open hardware allows decoupling of control, can spur adoption (*OpenFlow*)