Innovation in the P4 “Stack”

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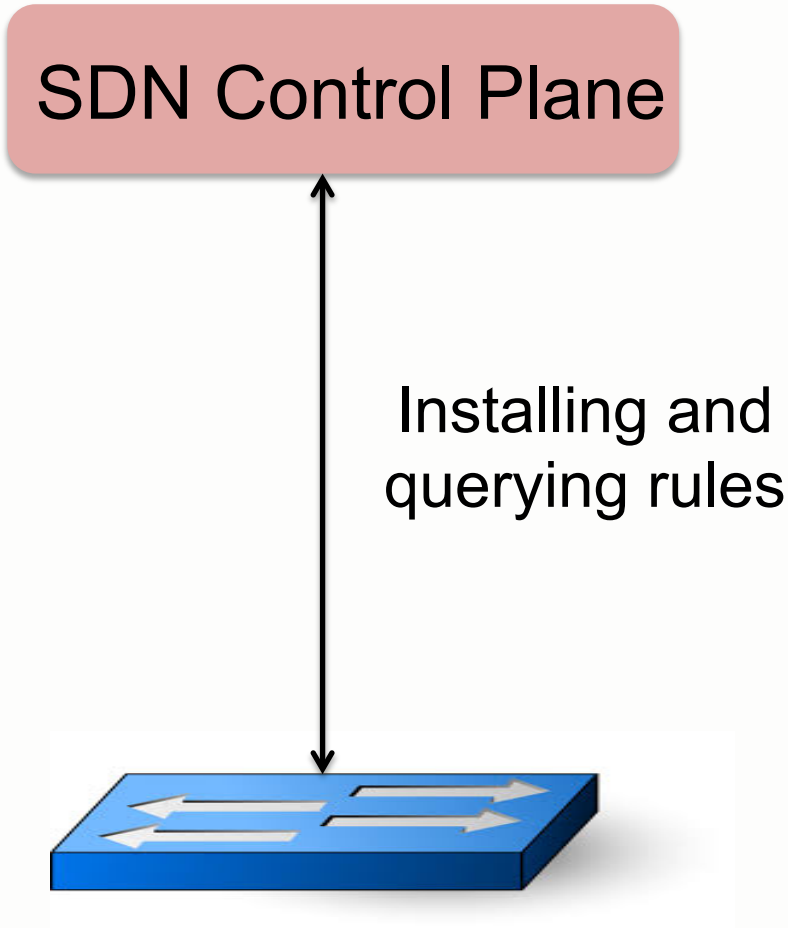
“Classic” OpenFlow (1.x)

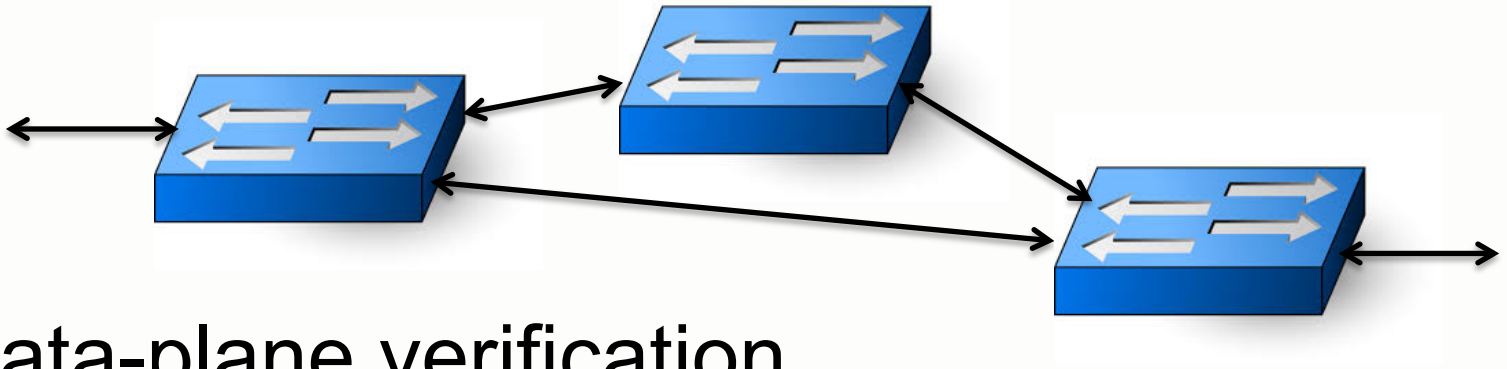


Simple API as a Magnet

- Simple, open interface
  - OpenFlow 1.0 table of match-action rules
  - … with a small set of headers and actions
- Useful recruiting aid
  - Programming languages
  - Verification
- Many success stories
  - Higher-level control abstractions
  - … and efficient analysis and compilation

Examples: Static Policies

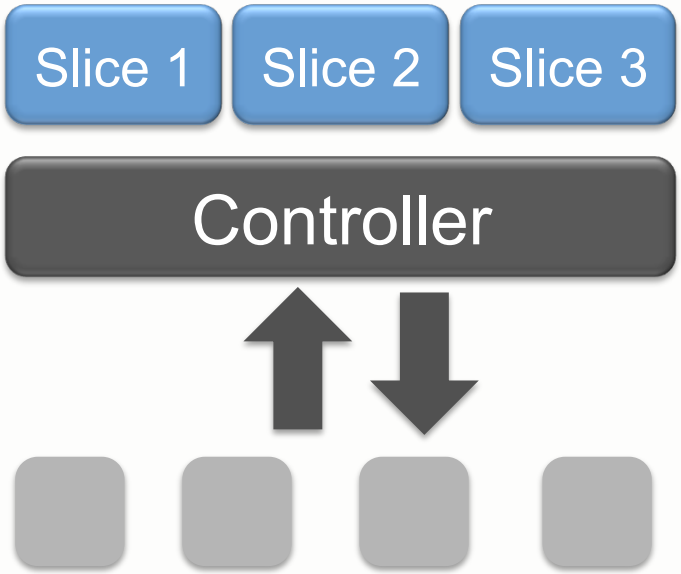
- Data-plane policy as a function
  - Input: located packet (header fields and location)
  - Output: a set of located packets



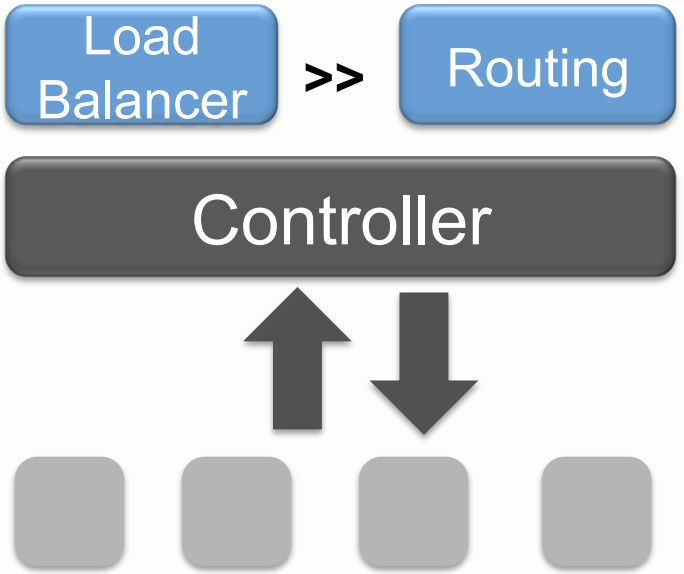
- Data-plane verification
  - Checking that the function satisfies invariants
  - E.g., no loops, no blackholes, access control, …

Examples: Combining Apps

- Slicing
  - Multiple tenants
  - Traffic isolation



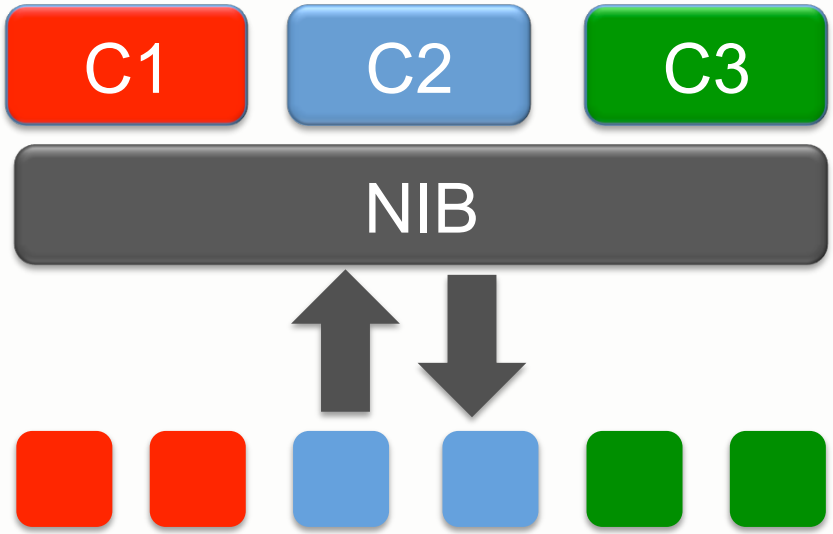
- Composition
  - Modular applications
  - On the same traffic



Examples: Network Topology

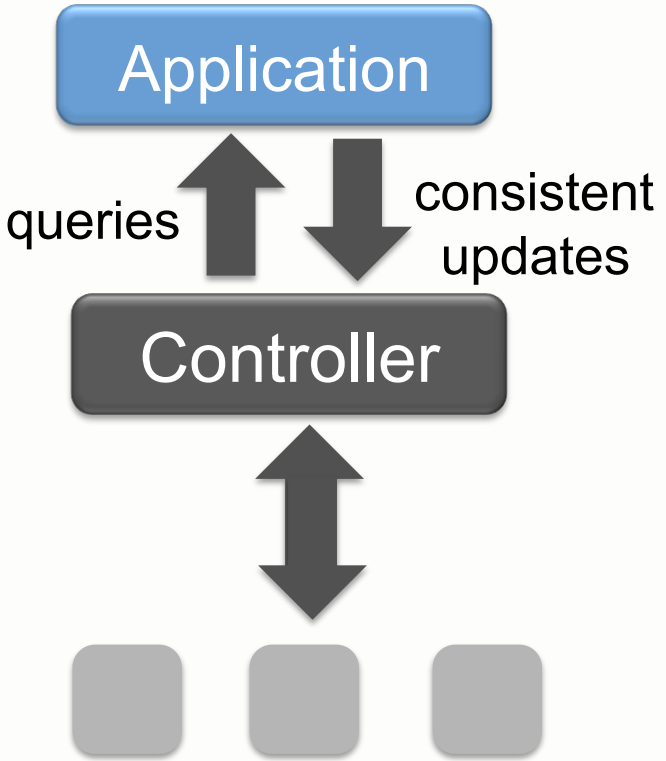
- Abstract topology
  - Controller apps see a virtual topology
  - E.g., one big switch
- Network Info Base
  - Network data model
  - Distributed key-value store

Firewall,
Load balancer



Examples: Reading/Writing State

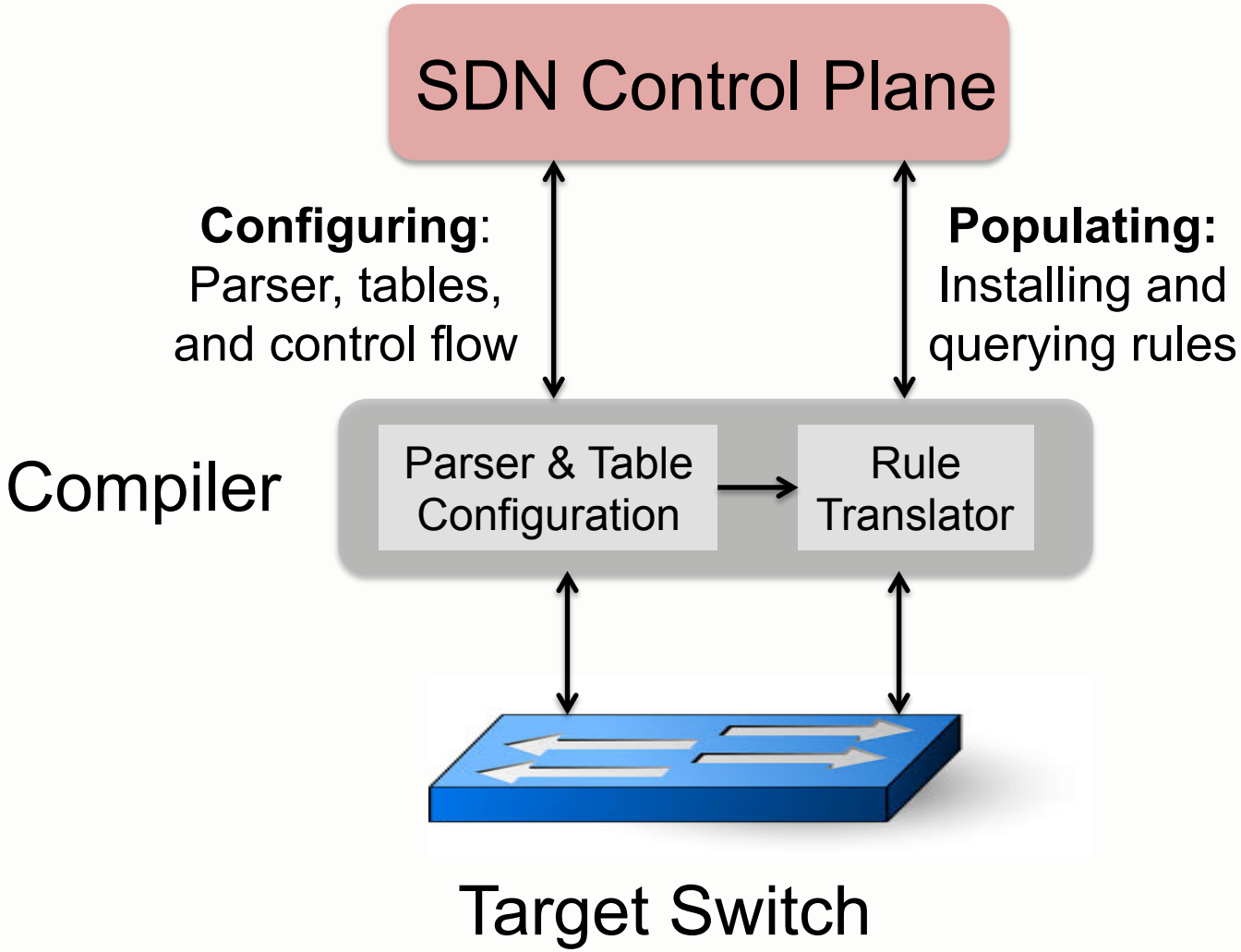
- Queries
  - Traffic and topology
  - Declarative
  - Modular
- Consistent updates
  - Transition from one policy to another
  - …while preserving key invariants



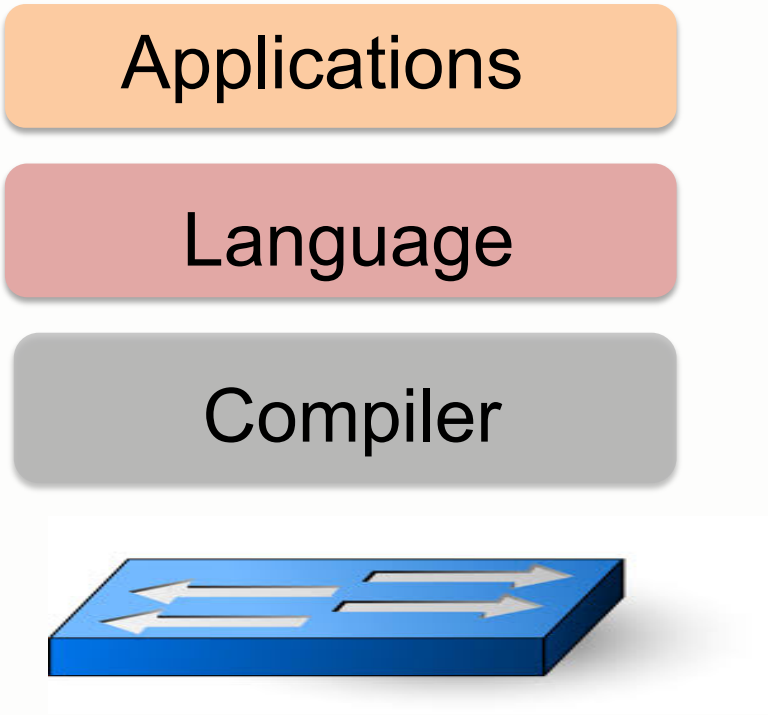
All taking OpenFlow 1.x “as is”…

… but now we can take these lessons and design a *better* interface

P4

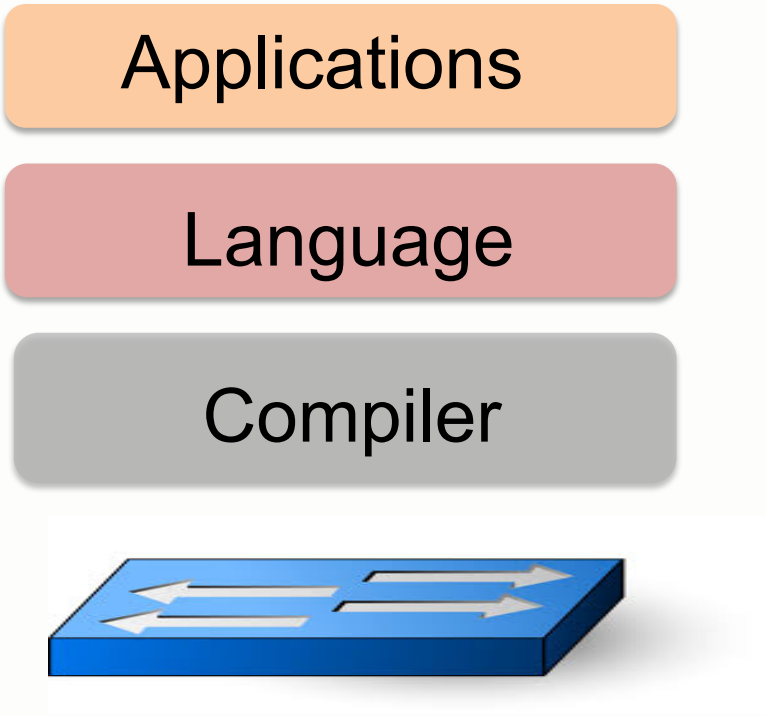

SDN Control Plane
Configuring:
Parser, tables,
and control flow
Populating:
Installing and
querying rules
Compiler
Parser & Table
Configuration
Rule
Translator
Target Switch

Many New Opportunities



- Applications
  - Compelling P4 apps
  - To stress-test the P4 design
  - … and identify gaps
- Language
  - Expression language for primitive actions
  - Support for modular programs
  - More flexible control flow
  - Unambiguous specification
  - QoS mechanisms, monitoring

Many New Opportunities



- Compiler
  - Exploiting opportunities for concurrency
  - Techniques for proving program equivalence
  - Making effective use of the target switch's resources
  - Updating a switch from one P4 program to another
  - Supporting a wide range of target switches

Collaboration Opportunities

- Crossing the divide
  - Industry with research
  - Computer networking with other fields
- Building a community
  - Open language
  - Open-source software
  - Repository of example P4 applications
  - Tutorials, workshops, hackathons, …
  - Summer internships for grad students

The Day Ahead

- 9:00-11:00: P4 community
- 11:00-11:30: Break/demos
- 11:30-12:30: Panel on user perspectives
- 12:30-1:30: Lunch/demos
- 1:30-3:00: Language evolution & research
- 3:00-3:30: Break/demos
- 3:30-5:00: Applications & targets
- 5:00-5:30: Wrap-up
- 5:30-6:30: Reception/demos

Demos

- Xilinx: P4 for an FPGA target
- Barefoot: Inband Network Telemetry in P4
- Dell: Tunnel splicing with visibility and monitoring
- Intel: P4 Applied to a vSwitch Data Plane
- Microsoft: Verification of P4 programs
- Netronome: P4 for Network Flow Processors
- Yale: Magellan: Compiling Datapath-Oblivious Packet Processors to P4
- Rocker: P4 switch support in Rocker
- USC: In-network layer-4 load balancing in P4
- ON.Lab: An ONOS controller for a P4 switch
- Princeton: Utilization Aware Load Balancing using P4

Thank you!