Software Defined Networking

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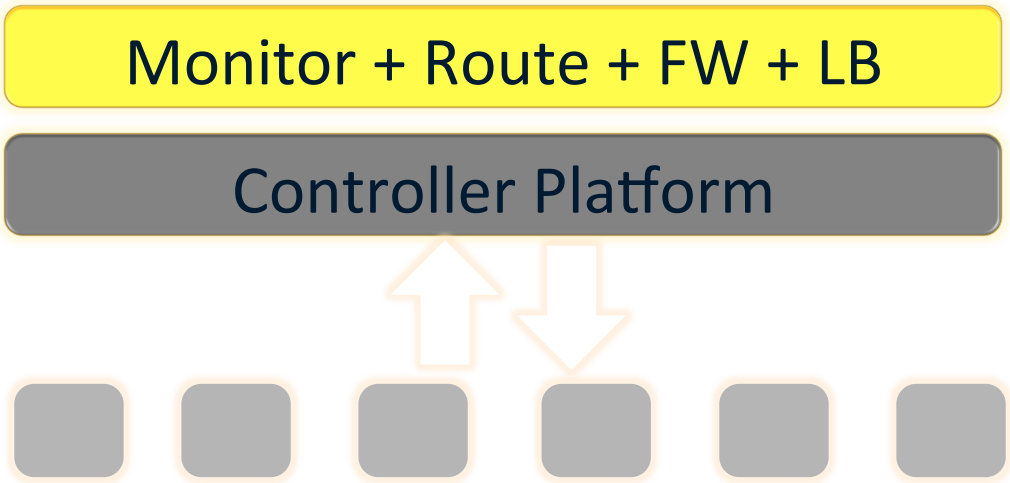
In this course, you will learn about software defined networking and how it is changing the way communications networks are managed, maintained, and secured.

This Module: Programming SDNs

- Four Lessons
  - Motivation for Programming SDNs
  - Programming Languages for SDNs
  - **Composing SDN Control**
    - Pyretic
  - Kinetic: Event-Driven SDN
- Programming Assignment
- Quiz

Networks Perform Many Tasks

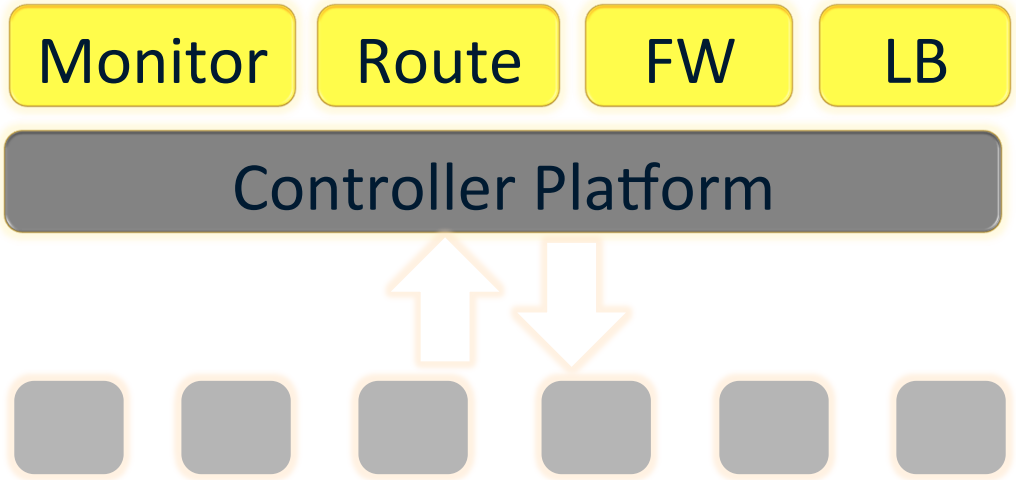
Monolithic application



Hard to program, test, debug, reuse, port, …

Solution: Modularize Control

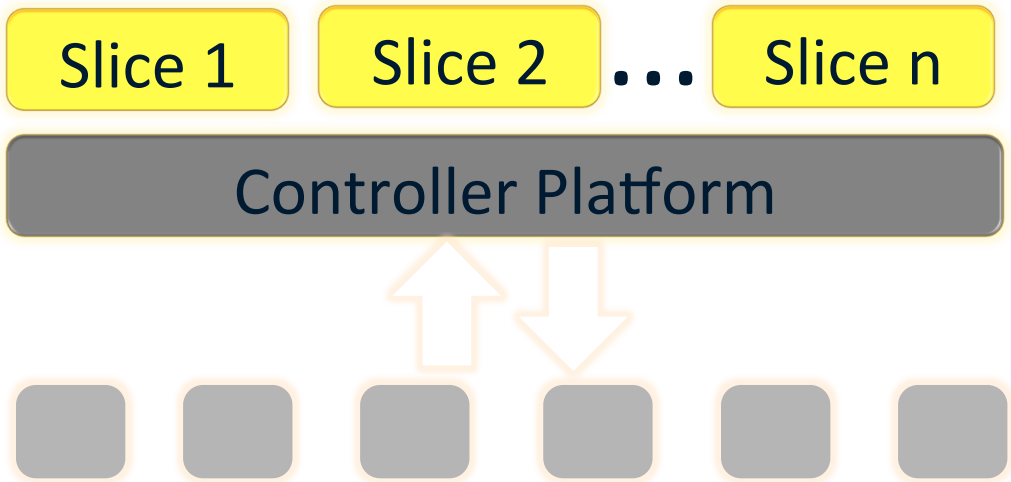
A module for each task



Easier to program, test, and debug
Greater reusability and portability

Modules Are Not Just "Tenants"

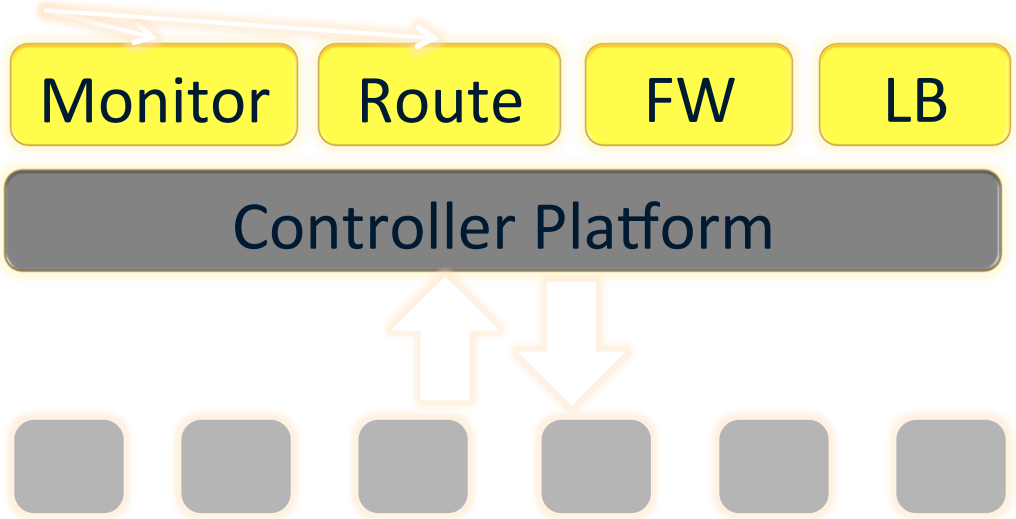
Each module controls a *different* portion of the traffic



Relatively easy to partition *rule space*, *link bandwidth*, and *network events* across modules

Modules Affect the *Same* Traffic

Each module *partially* specifies the handling of the traffic



How to combine modules into a complete application?

Approach: Composition

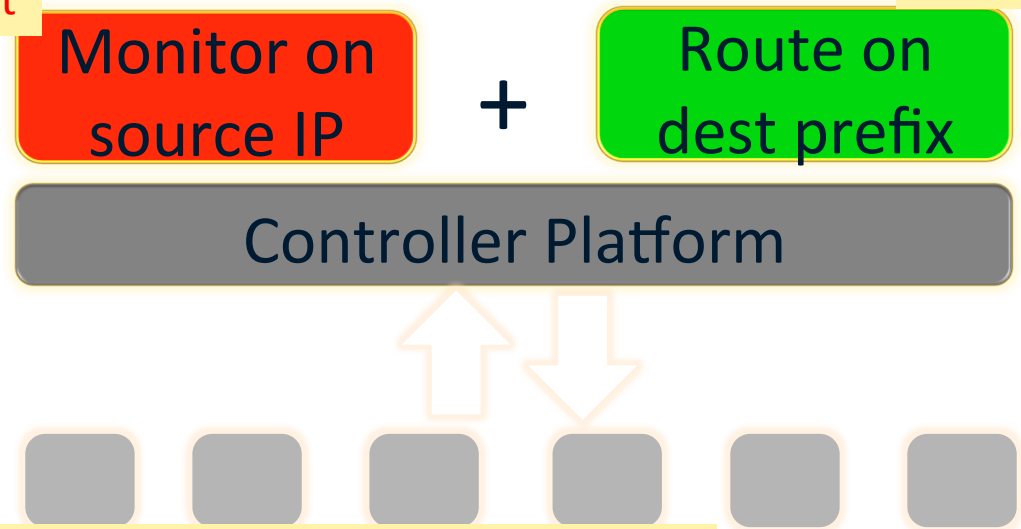
- **Parallel composition:** Perform both operations simultaneously (e.g., counting, forwarding)

- **Sequential composition:** Perform one operation, then the next (e.g., firewall then switch)

Parallel Composition

srcip = 5.6.7.8 → count
srcip = 5.6.7.9 → count

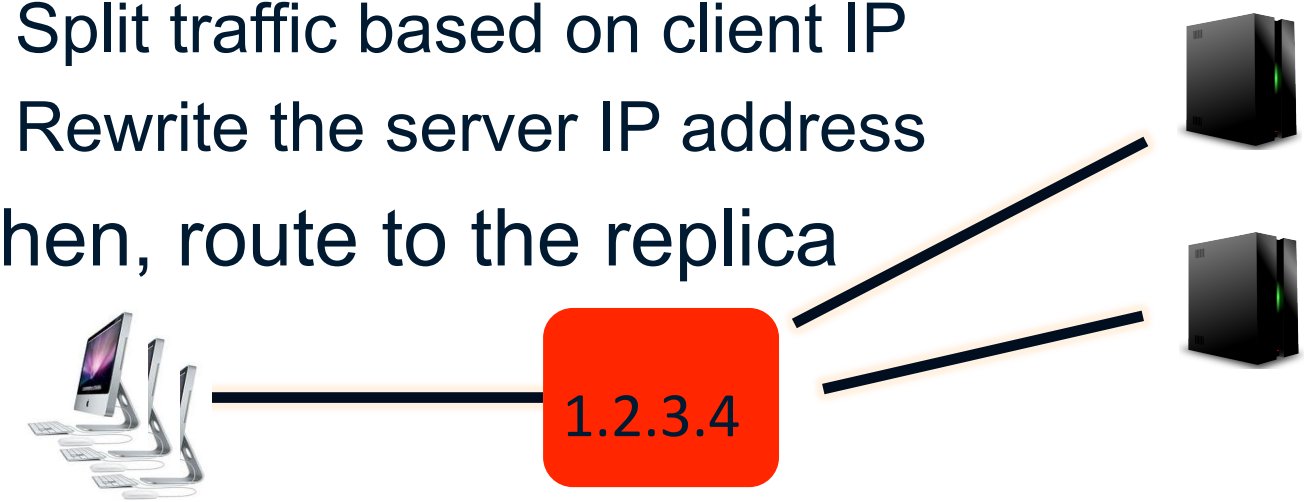
dstip = 1.2/16 → fwd(1)
dstip = 3.4.5/24 → fwd(2)



srcip = 5.6.7.8, dstip = 1.2/16 → fwd(1), count
srcip = 5.6.7.8, dstip = 3.4.5/24 → fwd(2), count
srcip = 5.6.7.9, dstip = 1.2/16 → fwd(1), count
srcip = 5.6.7.9, dstip = 3.4.5/24 → fwd(2), count

Another Example: Server Load Balancer

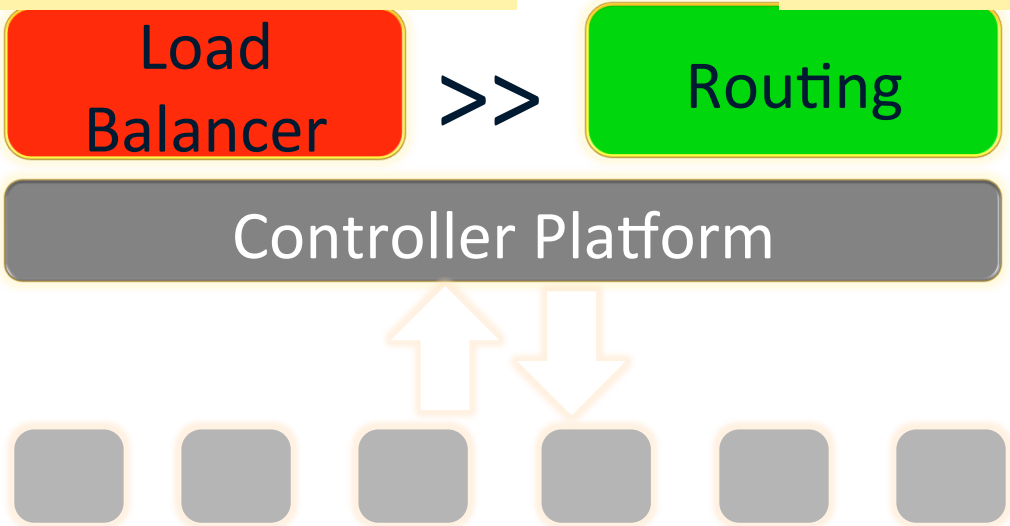
- Spread client traffic over server replicas
  - Public IP address for the service
  - Split traffic based on client IP
  - Rewrite the server IP address
- Then, route to the replica



Sequential Composition

srcip = 0*, dstip=1.2.3.4 → dstip=10.0.0.1
srcip = 1*, dstip=1.2.3.4 → dstip=10.0.0.2

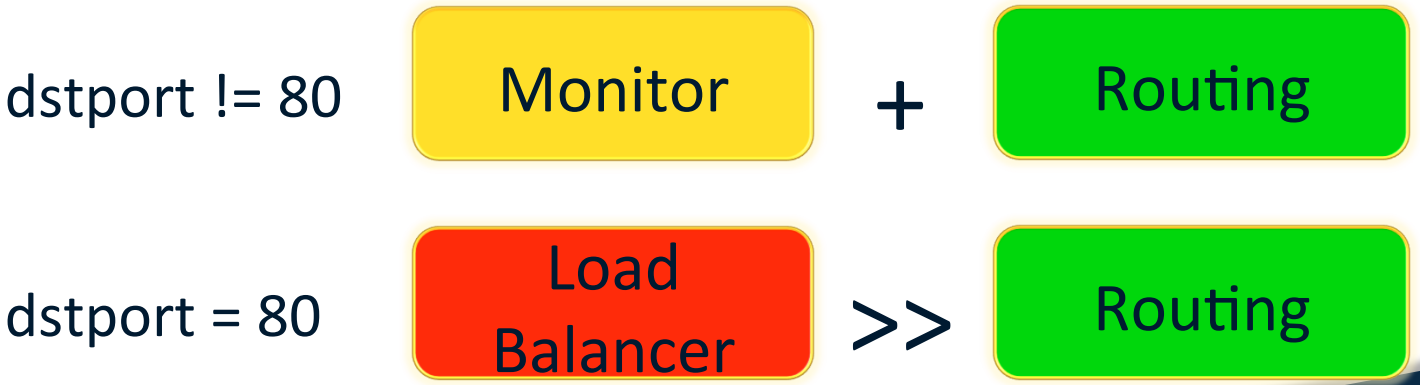
dstip = 10.0.0.1 → fwd(1)
dstip = 10.0.0.2 → fwd(2)



srcip = 0*, dstip = 1.2.3.4 → dstip = 10.0.0.1, fwd(1)
srcip = 1*, dstip = 1.2.3.4 → dstip = 10.0.0.2, fwd(2)

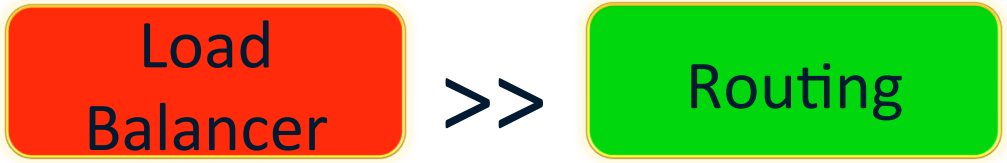
Dividing the Traffic Over Modules

- Predicates
  - Specify which traffic traverses which modules
  - Based on input port and packet-header fields



Partially Specifying Functionality

- A module should not specify *everything*
  - Leave some flexibility to other modules
  - Avoid tying the module to a specific setting
- Example: load balancer plus routing
  - Load balancer spreads traffic over replicas
  - … without regard to the network paths



Avoid custom interfaces between the modules

Abstract Topology Views

- Present abstract topology to the module
  - Implicitly encodes the constraints
  - Looks just like a normal network
  - Prevents the module from overstepping

13

Separation of Concerns

- Hide irrelevant details
  - Load balancer doesn't see the internal topology or any routing changes

Summary

- SDN control programs perform many tasks on the same traffic
- Requirements
  - **Compositional operators:** Specifying how to compose those policies
  - **Logical switch abstraction:** Hiding irrelevant details
- **Next Lecture:** Pyretic Language