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Software Defined Networking



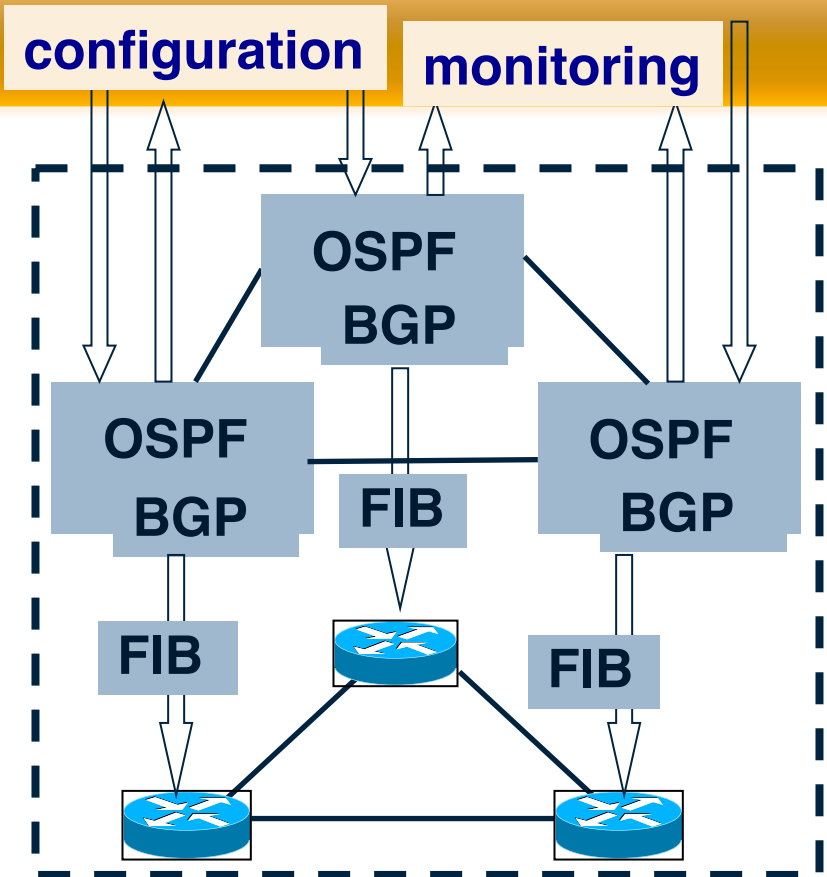
In this course, you will learn about software defined networking and how it is changing the way communications networks are managed, maintained, and secured.

This Module: 4D Network Architecture

- The “4D” Network Architecture
 - Motivation
 - Defining the 4Ds
- How 4D Terminology Relates to SDN Today

Conventional IP Routers

- Management plane
 - Construct network-wide view
 - Configure the routers
- Control plane
 - Track topology changes
 - Compute routes and install forwarding tables
- Data plane
 - Forward, filter, buffer, mark, and rate-limit packets
 - Collect traffic statistics



Goal: Remove (Conventional) Control Plane

- Faster innovation
 - Remove dependence on vendors and the IETF
- Simpler management systems
 - No need to “invert” control-plane operations
- Easier interoperability between vendors
 - Compatibility necessary only in “wire” protocols
- Simpler, cheaper routers
 - Little or no software on the routers

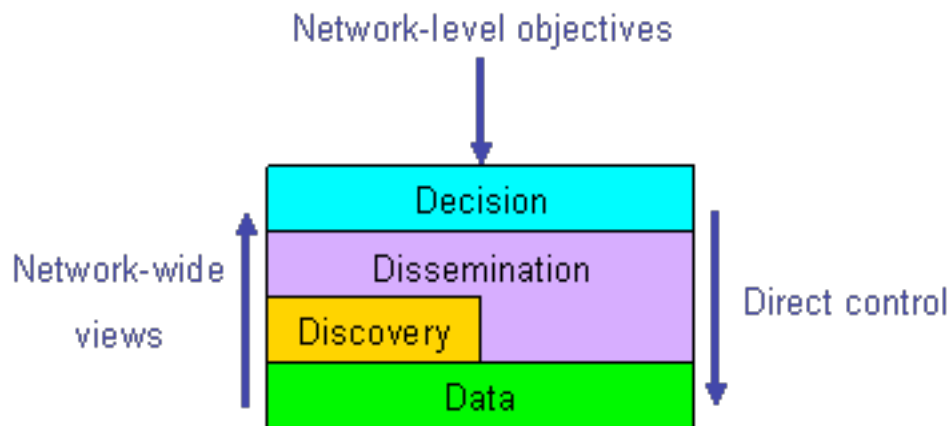
Removing the Control Plane From Routers

- Control software can run elsewhere
- State and computation is reasonable
- System overhead can be amortized
- Easier access to other information
- Some control can move to end hosts

Three Goals of 4D Architecture

- ⊙ Network-level objectives
 - Configure the *network*, not the routers
 - Minimize the maximum link utilization
 - Connectivity under all layer-two failures
- ⊙ Network-wide views
 - Complete *visibility* to drive decision-making
 - Traffic matrix, network topology, equipment
- ⊙ Direct control
 - Direct, sole control over data-plane configuration
 - Packet forwarding, filtering, marking, buffering...

The “4D” Planes

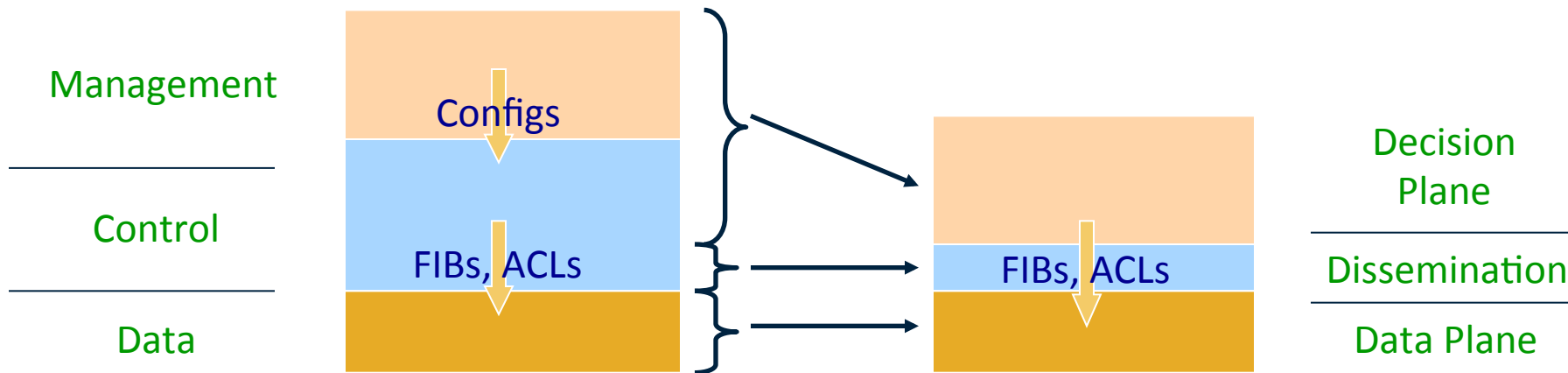


- ⦿ **Decision:** all management and control
- ⦿ **Dissemination:** communication to/from routers
- ⦿ **Discovery:** topology and traffic monitoring
- ⦿ **Data:** traffic handling

Dissemination and Decision Planes

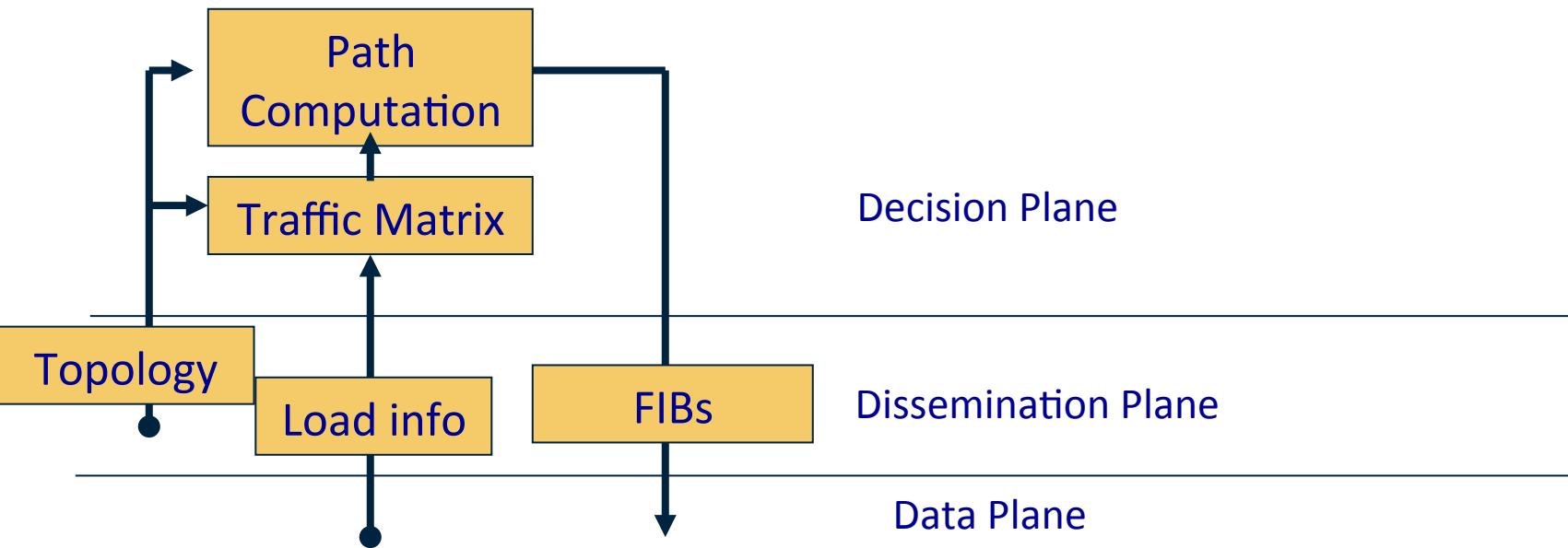
- ⦿ **Decision Plane:** Functions that operate on **view of entire network** and network objectives
 - Path selection and traffic engineering
 - Reachability control and VPNs
- ⦿ **Dissemination Plane:** Functions that **support creation of a network-wide view**
 - Topology discovery
 - Report measurements, status, resources
 - Install state (e.g., FIBs, ACLs) into data-plane

Good Abstractions Reduce Complexity



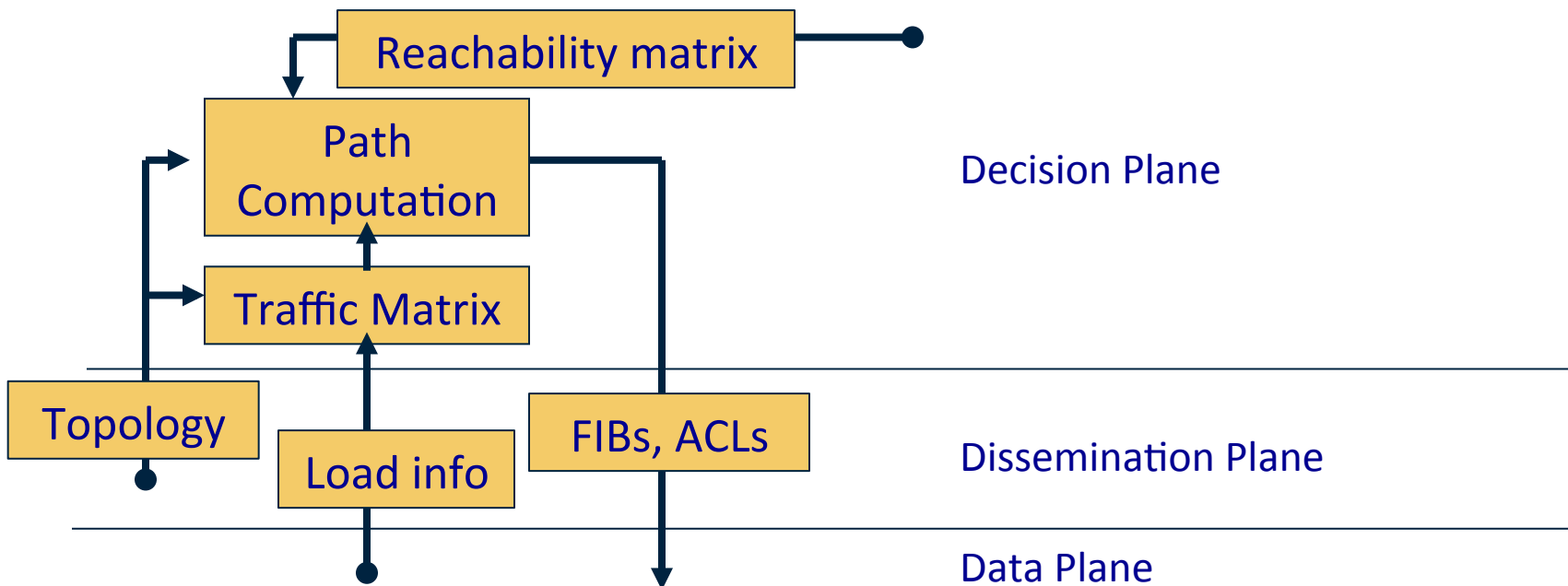
- Dissemination plane is a control channel between the decision plane and the data plane
- Routing protocols become a control channel. Complex logic in decision plane.

Traffic Engineering in 4D



- **Dissemination Plane:** Consistent network-wide view
- **Decision Plane:** Decision Logic that directly expresses desired solution

Traffic Isolation in 4D



- Decision Plane
 - Reachability matrix **directly expresses** goal
 - Path computation can **jointly** optimize traffic load and obey reachability constraints
- Packet filters installed only where needed

SDN Still Have a “Control Plane”, but It’s Not What 4D Called a Control Plane

- What the 4D calls the “control plane” is actually distributed routing protocols
- What we refer to as the “control plane” today is the “decision plane” in 4D
- The “dissemination plane” lives on, but we call it a “control channel”
 - In RCP, dissemination plane is BGP
 - In OpenFlow, it’s “secchan”

Summary

◎ Four layers

- **Data:** for processing packets
- **Discovery:** for collecting topology and traffic
- **Dissemination:** installing packet-processing rules
- **Decision:** logically centralized controllers convert objectives into packet-handling state

◎ 4D is a generalization of RCP

- Others followed up with more general implementations