



Workshop on P4 Programmable Switches

Hands-on Session 1: P4 Programming Building Blocks

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University of South Carolina (USC)

August 22, 2023

Introduction to P4 Lab Series

Lab experiments

- Lab 1: Introduction to Mininet
- Lab 2: Introduction to P4 and BMv2
- Lab 3: P4 Program Building Blocks
- Lab 4: Parser Implementation
- Lab 5: Introduction to Match-action Tables (Part 1)
- Lab 6: Introduction to Match-action Tables (Part 2)
- Lab 7: Populating and Managing Match-action Tables
- Lab 8: Checksum Recalculation and Packet Deparsing

Exercises

- Exercise 1: Building a Basic Topology
- Exercise 2: Compiling and Testing a P4 Program
- Exercise 3: Parsing UDP and RTP
- Exercise 4: Building a Simplified NAT
- Exercise 5: Configuring Tables at Runtime
- Exercise 6: Building a Packet Reflector

P4 Applications and Custom Processing Lab Series

Lab experiments

Lab 1: Introduction to Mininet

Lab 2: Introduction to P4 and BMv2

Lab 3: P4 Program Building Blocks

Lab 4: Defining and processing custom headers

Lab 5: Monitoring the Switch's Queue using Standard Metadata

Lab 6: Collecting Queueing Statistics using a Header Stack

Lab 7: Measuring Flow Statistics using Direct and Indirect Counters

Lab 8: Rerouting Traffic using Meters

Lab 9: Storing Arbitrary Data using Registers

Lab 10: Calculating Packets Interarrival Times using Hashes and Registers

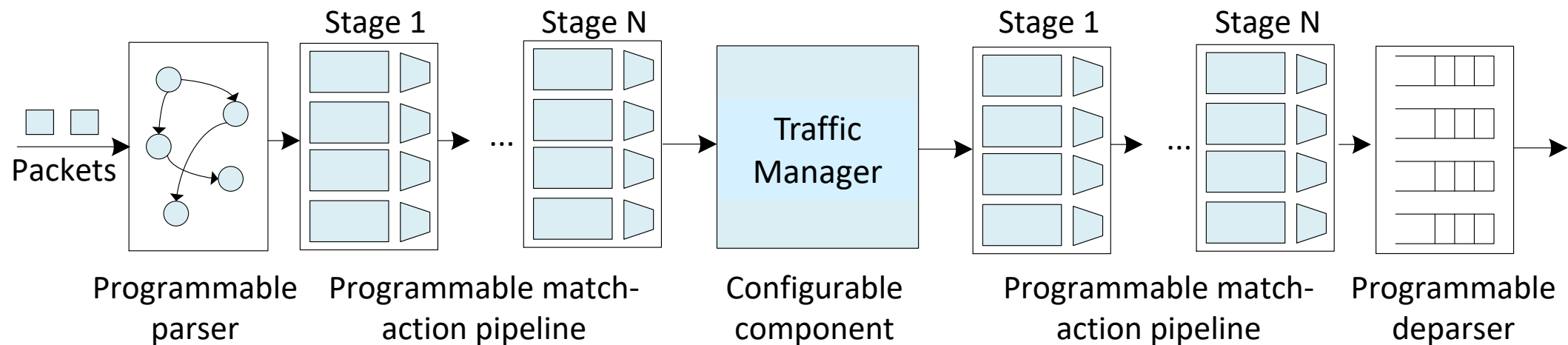
Lab 11: Generating Notification Messages from the Data Plane using Digests

P4 Program Building Blocks

Lab activities are described in Lab 3, P4 Applications and Custom Processing lab series

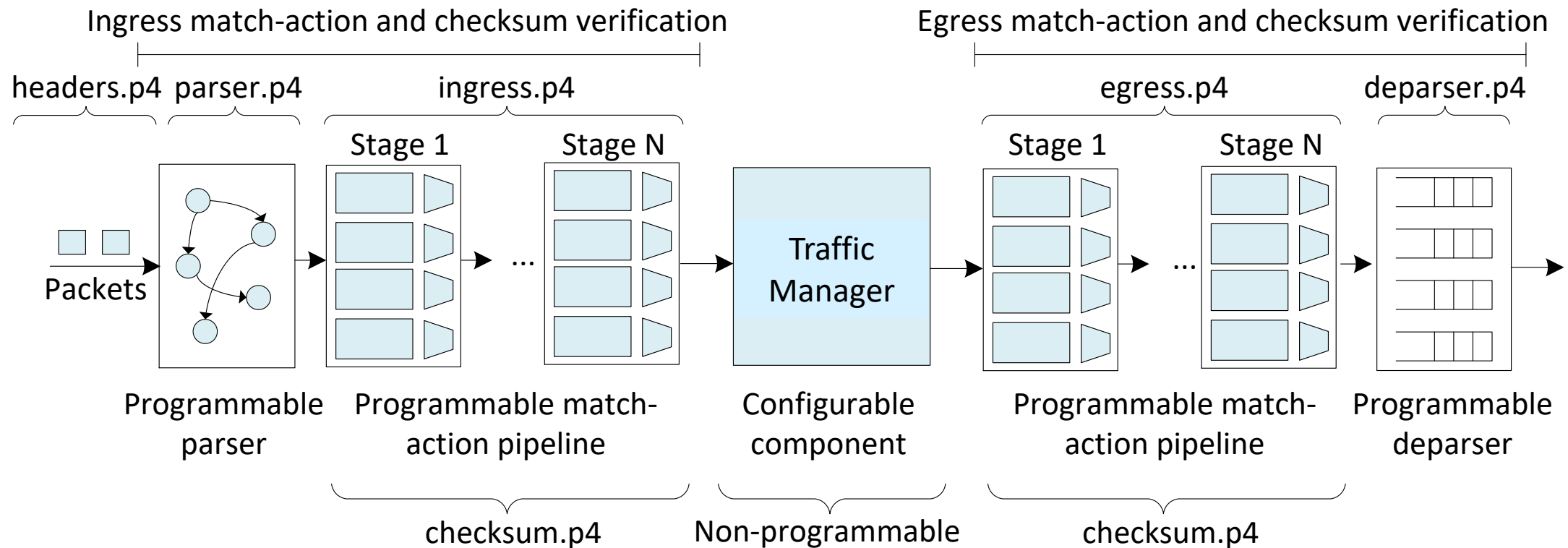
V1 Model

- Common P4₁₆ architecture used with BMv2
- Implemented on top of BMv2's *simple_switch* target
- It consists of a programmable parser, an ingress match action pipeline, a traffic manager, an egress match-action pipeline, and a deparser



V1 Model

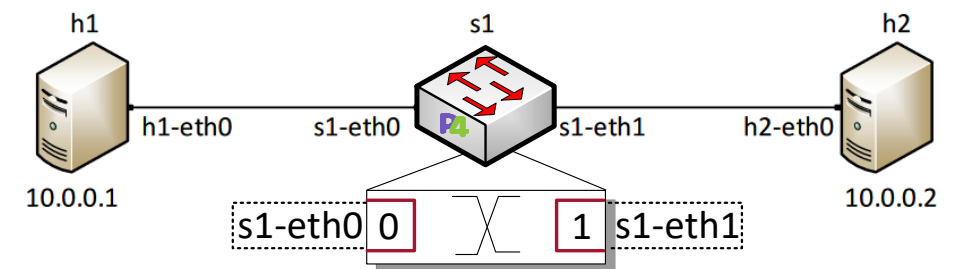
- Common P4₁₆ architecture used with BMv2
- Implemented on top of BMv2's *simple_switch* target



Lab Topology and Objectives

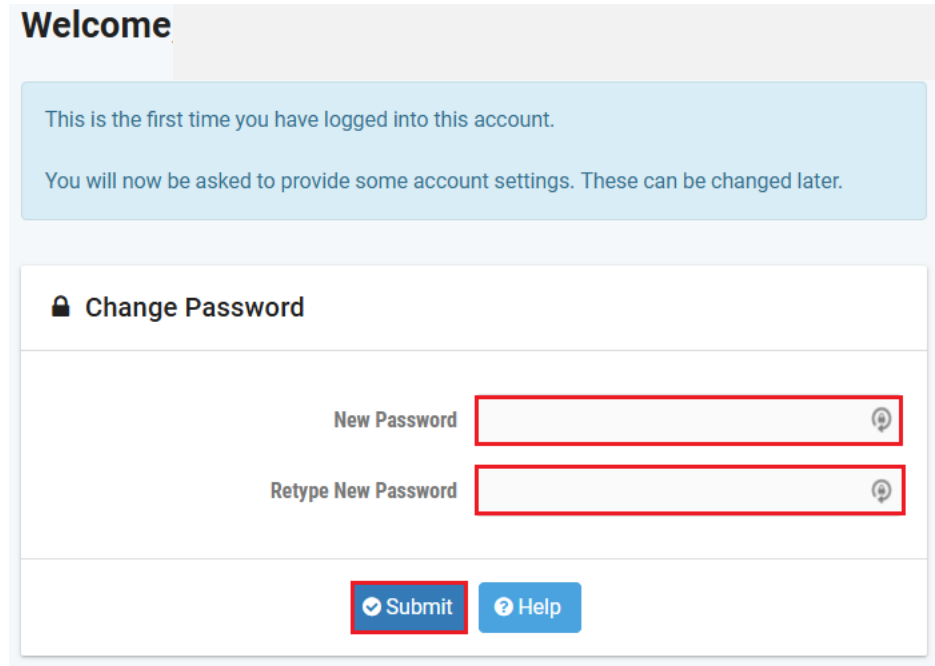
- The topology consists of two hosts: h1 and h2; one P4 switch: s1
- The objectives are:
 - Mapping the P4 program components to the components of the programmable pipeline
 - Trace the lifecycle of a packet as it traverses the pipeline

```
root@s1: /behavioral-model
root@s1:/behavioral-model# simple_switch -i 0@s1-eth0 -i 1@s1-eth1 basic.json &
[1] 34
root@s1:/behavioral-model# Calling target program-options parser
Adding interface s1-eth0 as port 0
Adding interface s1-eth1 as port 1
```



Accessing the Platform

- Please use the following link to access the platform:
 - <https://netlab.cec.sc.edu/>
- Login using your credentials
- **Username:** your_email_address (e.g., jsmith@usc.edu)
- **Temporary Password:** nsf2023



Cyberinfrastructure
Lab @ UofSC

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 - <https://netlab.cec.sc.edu/>
- Login using your credentials
- **Username:** your_email_address (e.g., jsmith@usc.edu)
- **Temporary Password:** nsf2023

The image displays two sequential screenshots of a web application interface, connected by orange arrows indicating a workflow.

Left Screenshot: Change E-mail Address

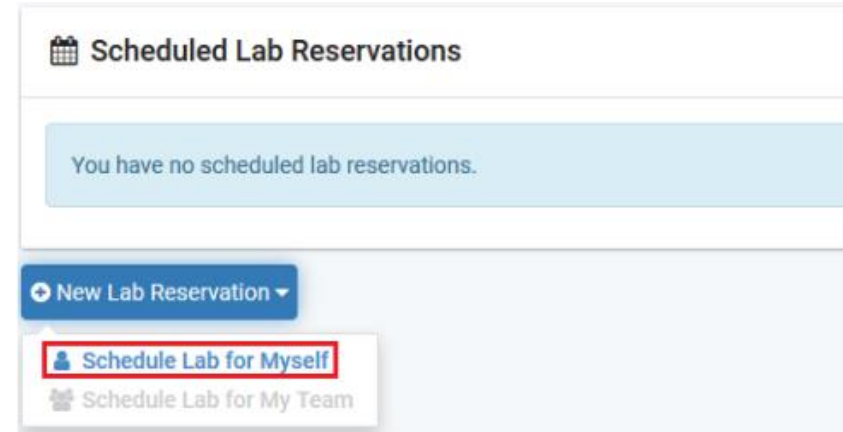
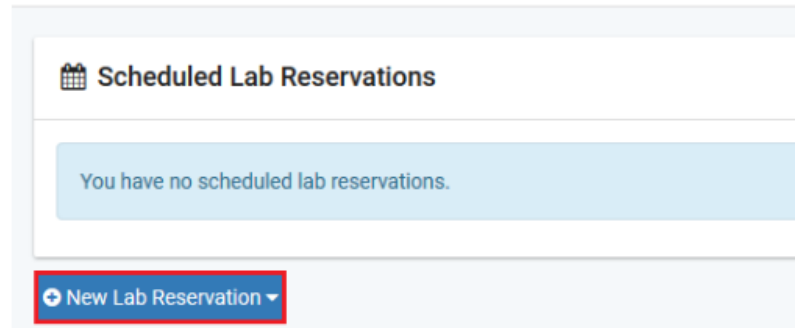
- Message: "Please enter a valid e-mail address. You can leave this blank if you do not want to receive e-mail from the system."
- Section: "Change E-mail Address" (with an envelope icon)
- Field: "E-mail Address" containing "testuser@example.edu"
- Buttons: "Submit" (highlighted with a red box) and "Help"

Right Screenshot: Date and Time Settings

- Section: "Date and Time Settings" (with a clock icon)
- Fields:
 - Time Zone: "(GMT-05:00) Eastern Time (US & Canada)"
 - Date Display Format: "YYYY-MM-DD (2016-09-15)"
 - Time Display Format: "24 Hour (15:37)"
 - First Day of Week: "Sunday"
- Buttons: "Submit" (highlighted with a red box) and "Help"

Scheduling a Reservation

- Click on New Lab Reservation
- Click on Schedule Lab for Myself



Scheduling a Reservation

- Select the course
- For this session, we will use “P4 Applications and Custom Processing”

Multiple course topics are available in this class. Please select one.

Intro. to P4 Programmable Data Planes

Introduction to P4 programmable data planes with BMv2

P4 Applications and Custom Processing

This lab series presents P4 applications, stateful elements, and custom packet processing

Scheduling a Reservation

- Select the Lab
- For this session, we will run:
 - Lab 3: P4 Program Building Blocks

⚠ This lab series presents P4 applications, stateful elements, and custom packet processing

Search

Lab Name	Action
Lab 1: Introduction to Mininet	▼
Lab 2: Introduction to P4 and BMv2	▼
Lab 3: P4 Program Building Blocks	▼
Lab 4: Defining and Processing Custom Headers	▼
Lab 5: Monitoring the Switch Queue using Standard Metadata	▼
Lab 6: Collecting Queueing Statistics using a Header Stack	▼
Lab 7: Measuring Flow Statistics using Direct and Indirect Counters	▼
Lab 8: Rerouting Traffic using Meters	▼
Lab 9: Storing Arbitrary Data using Registers	▼
Lab 10: Calculating Packets Interarrival Times using Hashes and Registers	▼
Lab 11: Generating Notification Messages from the Data Plane using Digests	▼

Show 50 entries Showing 1 to 11 of 11 items

< 1 >

Scheduling a Reservation

- Select the next available POD and allocate time

Pod Scheduler

August - 2023 -

Sun	Mon	Tue	Wed	Thu	Fri	Sat
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2

Selected Day
August
21
2023

Current Time
10:53
Eastern Time (US & Canada)

	P4v2_H1_6001	P4v2_H2_6002	P4v2_H3_6003	P4v2_H1_6004
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
16:00				



Pod Scheduler

Add Reservation

Pod P4v2_H2_6002

Reservation Type Instructor Private Reservation

Reserve For Jose Gomez

Lab Exercise Lab 3: P4 Program Building Blocks

Time Zone Eastern Time (US & Canada)

Start Time 2023-08-21 10:54

End Time 2023-08-21 11:30

Length of Reservation 25 mins.

Submit

Previous

Cancel

Platform Information

We will use the NETLAB virtual platform:

- **URL:** <https://netlab.cec.sc.edu/>
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- **Temporary Password:** nsf2023