

Introduction to P4 and BMv2

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The Cyberinfrastructure Lab at UofSC
Energy Sciences Network (ESnet)
National Science Foundation (NSF)

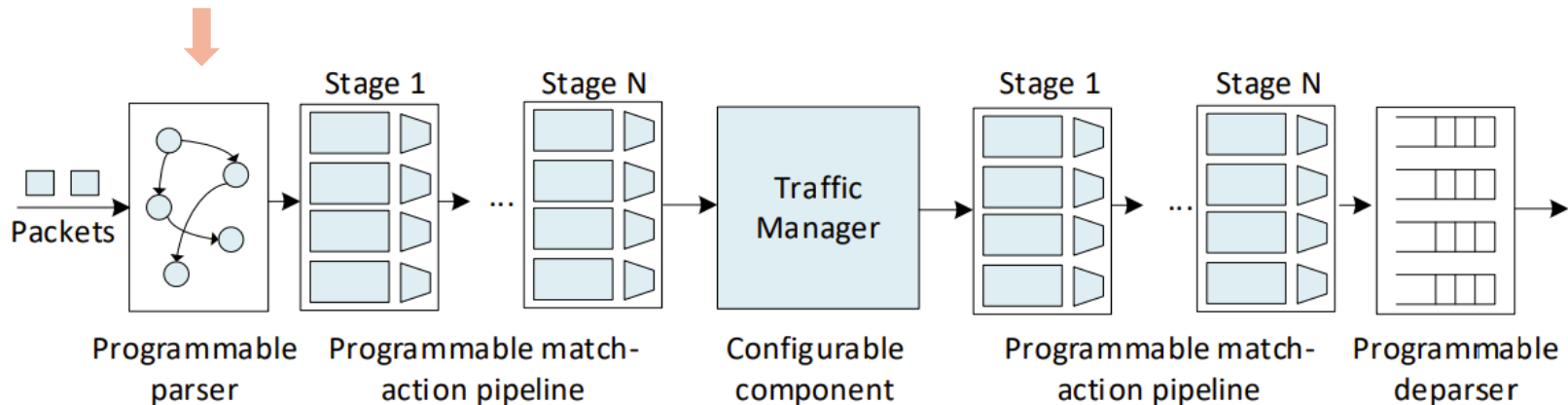
Internet2 Technology Exchange

Monday December 5th, 2022
Denver, Colorado

Hands on Session 1: Writing a Parser for IPv4 and IPv6

Programmable Parser

- The parser enables parsing arbitrary headers with a finite state machine
- The state machine defines the order of the headers within the packets
- The packet is split into the defined headers and the remaining is treated as the payload



Packet Headers

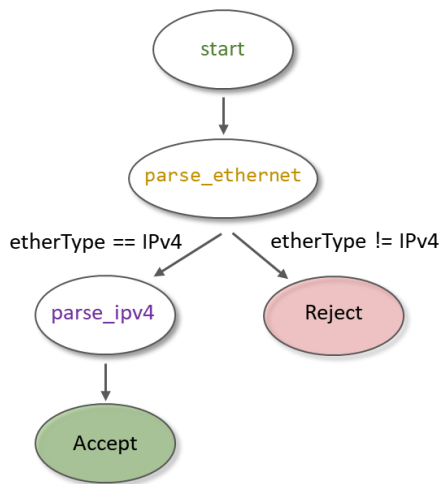
- The packet headers are specified by the programmer
- The programmer has the flexibility of defining custom/non-standardized headers
- Such capability is not available in non-programmable devices

Bit	0	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
0	Version				IHL				DSCP				ECN				Total Length															
32	Identifier												Flags				Fragment Offset															
64	Time To Live								Protocol								Header Checksum															
96	Source IP Address																															
128	Destination IP Address																															
160	Options (if IHL > 5)																															

```
header ipv4_t {  
    bit<4> version;  
    bit<4> ihl;  
    bit<8> diffserv;  
    bit<16> totalLen;  
    bit<16> identification;  
    bit<3> flags;  
    bit<13> fragOffset;  
    bit<8> ttl;  
    bit<8> protocol;  
    bit<16> hdrChecksum;  
    ip4Addr_t srcAddr;  
    ip4Addr_t dstAddr;  
}
```

Programmable Parser

- The parser enables declaring arbitrary headers with a finite state machine
- The state machine defines the order of the headers within the packets

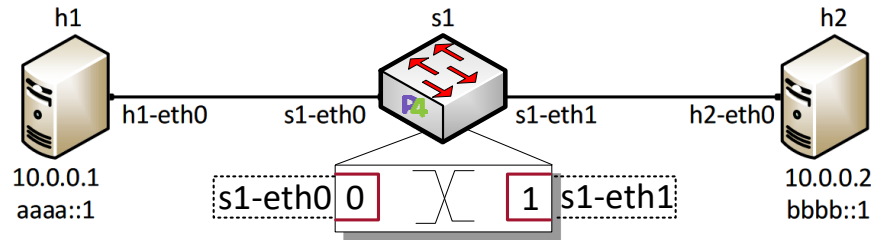


```
state start {
    transition parse_ethernet;
}
state parse_ethernet {
    packet.extract(hdr.ethernet);
    transition select(hdr.ethernet.etherType) {
        TYPE_IPV4: parse_ipv4;
        default: reject;
    }
}
state parse_ipv4 {
    packet.extract(hdr.ipv4);
    transition accept;
}
```

Lab 4: Parser Implementation

Lab Topology and Objectives

- The topology consists of two hosts: h1 and h2; one P4 switch: s1
- Defining the headers for Ethernet, IPv4 and IPv6
- Implementing the parser
- Testing and verifying the switch behavior when IPv4 and IPv6 packets are received



Headers Format

- Ethernet header:

48 bits	48 bits	16 bits
Destination Address	Source Address	Ether Type

- IPv4 header:

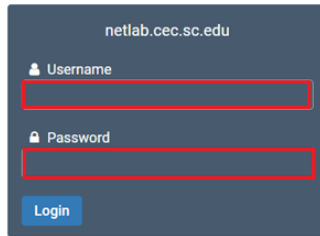
Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	Version			IHL			DSCP			ECN		Total Length																				
32	Identifier														Flags		Fragment Offset															
64	Time To Live						Protocol						Header Checksum																			
96	Source IP Address																															
128	Destination IP Address																															
160	Options (if IHL > 5)																															

- IPv6 header:

Bit	0	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	
0	Version			Traffic Class						Flow Label																							
32	Payload Length												Next Header						Hop Limit														
64	Source IP Address																																
192	Destination IP Address																																

Accessing the Platform

- Please use the following link to access the platform:
 - <https://netlab.cec.sc.edu/>
- Login using your credentials

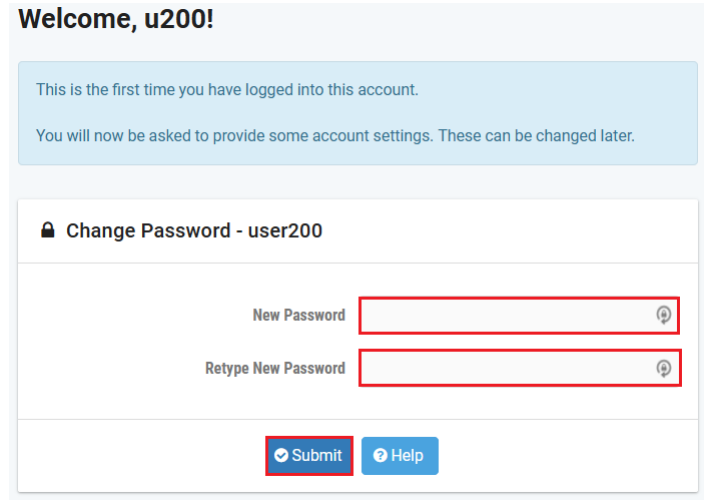


netlab.cec.sc.edu

Username

Password

Login



Welcome, u200!

This is the first time you have logged into this account.

You will now be asked to provide some account settings. These can be changed later.

Change Password - user200

New Password

Retype New Password

Submit Help

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- Please use the following link to access the platform:
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Please enter a valid e-mail address.
You can leave this blank if you do not want to receive e-mail from the system.

✉ Change E-mail Address

E-mail Address

🕒 Date and Time Settings

Time Zone

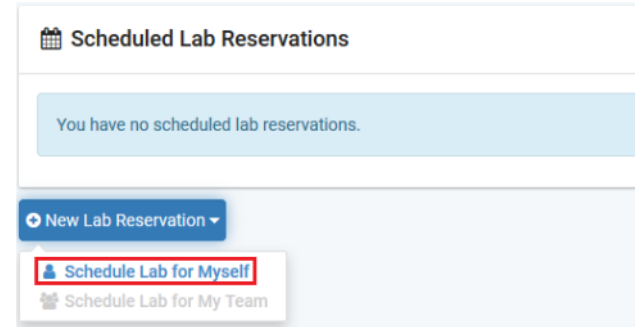
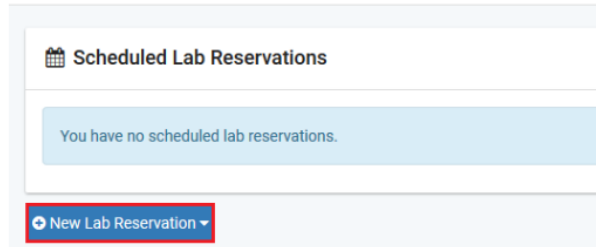
Date Display Format

Time Display Format

First Day of Week

Scheduling a Reservation

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



Internet2 Workshop 2 - P4 Programmable Data Planes	Jorge Crichigno, Jose Gomez, Elie Kfoury, Ali Sabeh	None	None
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Show entries Showing 1 to 2 of 2 items < 1 >

Scheduling a Reservation

- Select the course
- For this session, we will use “Intro. To P4 Programmable Data Planes”

Multiple course topics are available. 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 4: Parser Implementation

Introduction to P4 programmable data planes with BMv2 Search	
Lab Name	Action
Lab 1: Introduction to Mininet	▼
Exercise 1: Building a Basic Topology	▼
Lab 2: Introduction to P4 and BMv2	▼
Exercise 2: Compiling and Running a P4 Program	▼
Lab 3: P4 Program Building Blocks	▼
Lab 4: Parser Implementation	▼
Exercise 3: Parsing UDP and RTP	▼
Lab 5: Introduction to Match-action Tables (Part 1)	▼
Lab 6: Introduction to Match-action Tables (Part 2)	▼
Exercise 4: Implementing NAT using Match-action Tables	▼
Lab 7: Populating and Managing Match-action Tables at Runtime	▼
Exercise 5: Configuring Match-action Tables at Runtime	▼

Scheduling a Reservation

- Select the next available POD and allocate time

Pod Scheduler

October - 2019 -

Sun Mon Tue Wed Thu Fri Sat

29 30 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
October 1 2019

Current Time
16:43
Eastern Time (US & Canada)

	NTP_H1_1201	NTP_H2_1202	NTP_H3_1203	NTP_H1_1204
16:00				
17:00	Reservation 4246			
18:00				
19:00				

Previous Cancel



Add Reservation

Pod **NTP_H2_1202**

Reservation Type **Individual Self Study**

Class Name **Cyberinfrastructure Training**

Reserve For **testuser**

Lab Exercise **Lab 1: Introduction to Mininet**

Time Zone **Eastern Time (US & Canada)**

Start Time **2019-10-01 16:49**

End Time **2019-10-01 19:00**

Length of Reservation **2 hrs.**

Submit Previous Cancel

Website URL and Accessing the Platform

- Tutorial website with slides and URL to resources:

http://ce.sc.edu/cyberinfra/workshop_2022_ie2_p4.html

- Access to virtual platform for this tutorial:

<https://netlab.cec.sc.edu/>