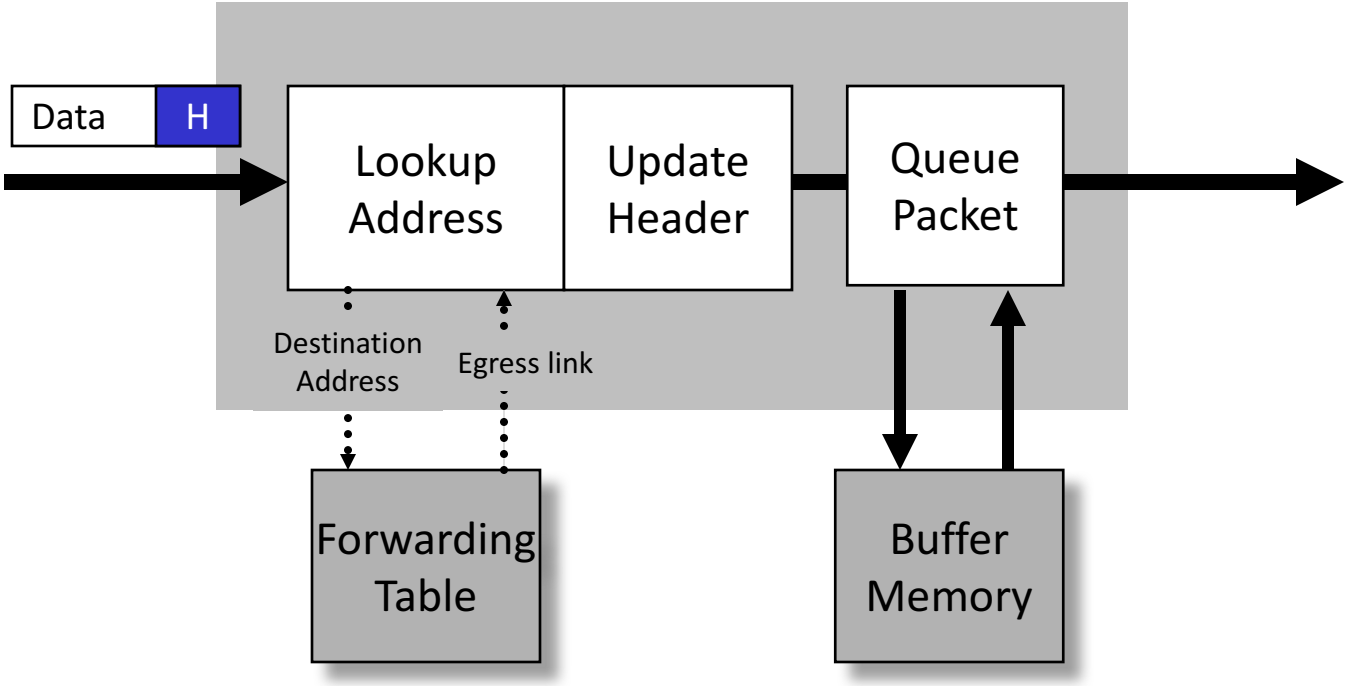
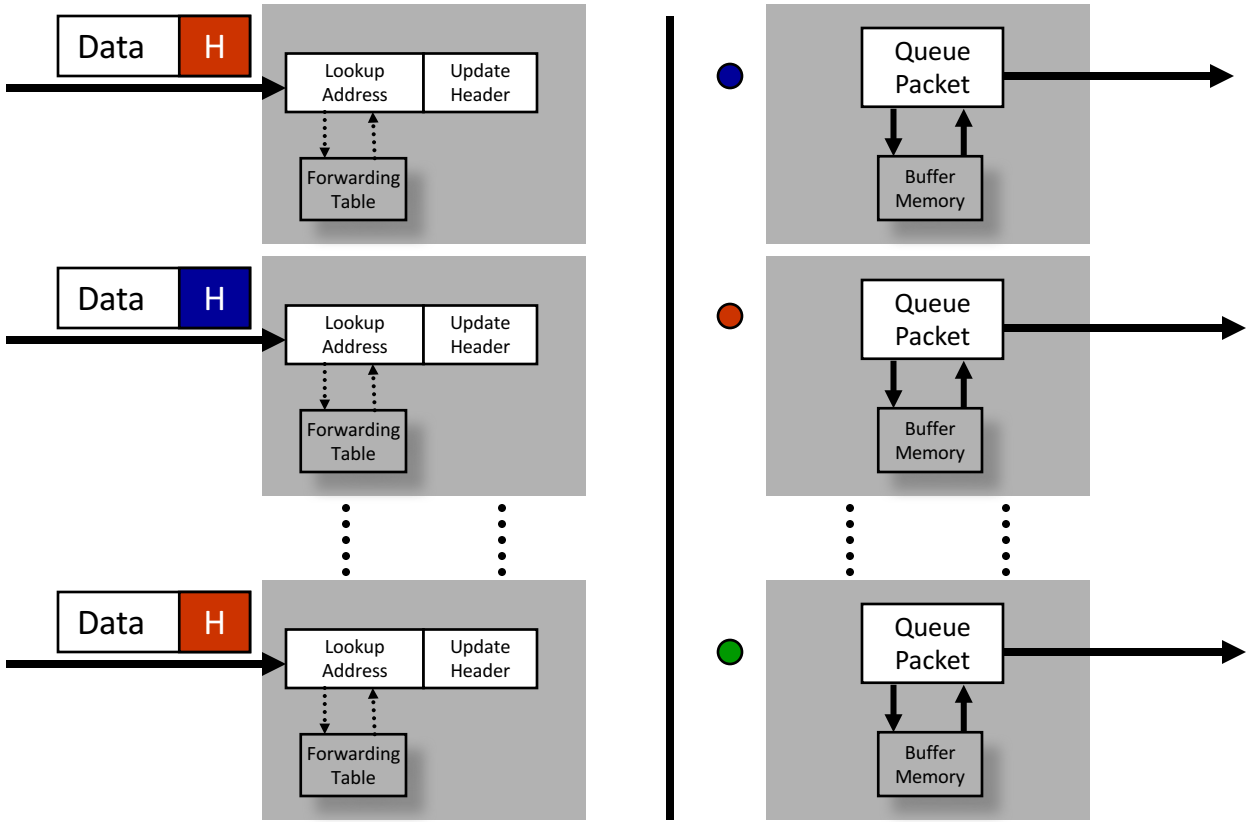
CS344 - Build an Internet Router

Nick McKeown, Steve Ibanez (TF)

Generic Packet Switch



Generic Packet Switch



Ethernet Switch

1. Examine the header of each arriving frame.
2. If the Ethernet DA is in the forwarding table, forward the frame to the correct output port(s).
3. If the Ethernet DA is not in the table, broadcast the frame to all ports (except the one through which the frame arrived).
4. Entries in the table are learned by examining the Ethernet SA of arriving packets.

Internet Router

1. If the Ethernet DA of the arriving frame belongs to the router, accept the frame. Else drop it.
2. Examine the IP version number and length of the datagram.
3. Decrement the TTL, update the IP header checksum.
4. Check to see if TTL == 0.
5. If the IP DA is in the forwarding table, forward to the correct egress port(s) for the next hop.
6. Find the Ethernet DA for the next hop router.
7. Create a new Ethernet frame and send it.

Basic Operations

1. Lookup Address: How is the address looked up in the forwarding table?
2. Switching: How is the packet sent to the correct output port?

Lookup Address: Ethernet

Ethernet addresses (in a switch)

Match	Action
Ethernet DA = 0xA8B72340E678	Forward to port 7
Ethernet DA = 0xB3D22571053B	Forward to port 3
…	…

Methods

- Store addresses in hash table (maybe 2-way hash)
- Look for exact match in hash table

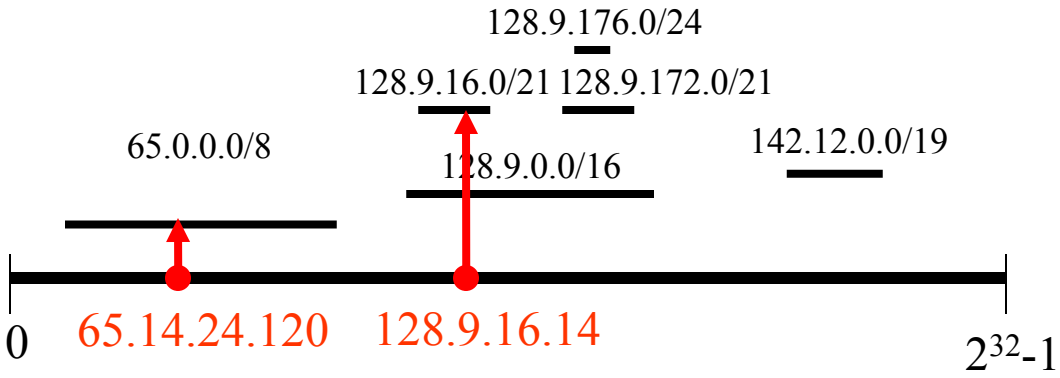
Lookup Address: IP

IP addresses (in a router)

Match	Action
IP DA = 127.43.57.99	Forward to 56.99.32.16
IP DA = 123.66.44.X	Forward to 22.45.21.126
IP DA = 76.9.X.X	Forward to 56.99.32.16
…	…

Lookup is a longest prefix match, not an exact match

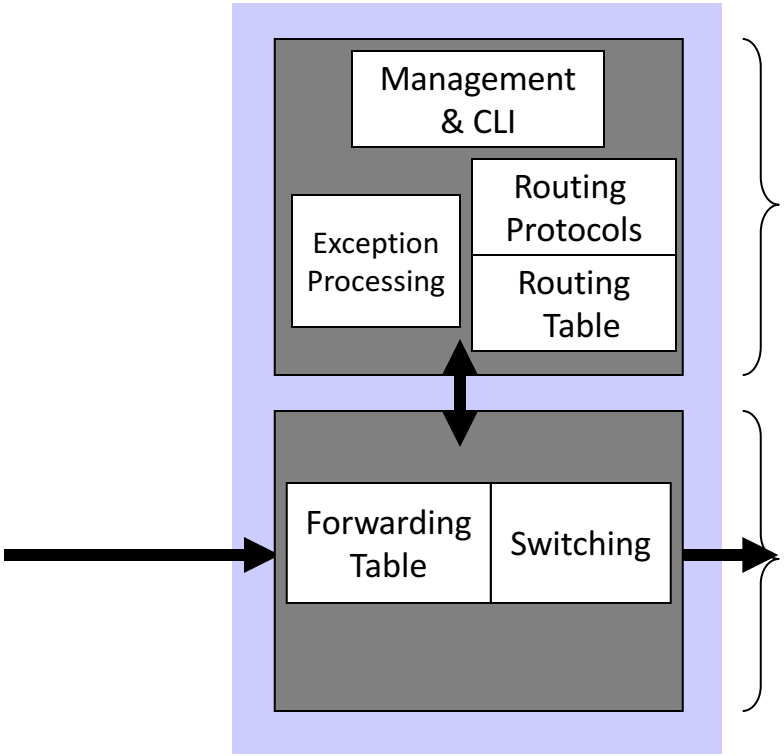
Longest prefix match



Routing lookup: Find the longest matching prefix (aka the most specific route) among all prefixes that match the destination address.

The CS344 Project:

Build a 4-port 10GE IPv4 Router



Software Team
Develop s/w in Linux on PC in lab

Hardware Team
Design h/w in P4 language on NetFPGA board in lab

LOGISTICS

Course Website

- **http://www.stanford.edu/class/cs344/**

CS344 Stanford

Build an Internet Router

About Documentation Policy Schedule Source Code Staff Teams Piazza

Time and Location

Term: Spring 2018

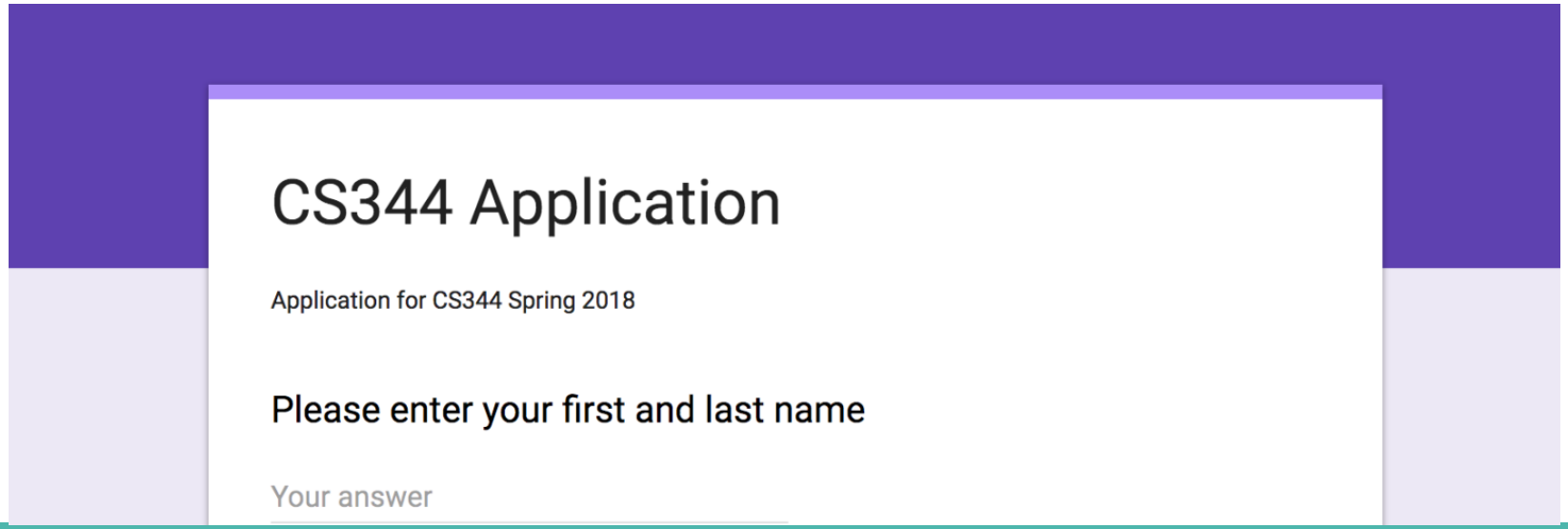
Lectures:

- Monday/Wednesday 4:30PM - 5:50PM
- 110-101 in the Main Quad

Lab: Gates 325

Course Application

- **tinyurl.com/cs344-application**
- **Team assignments: tomorrow by 5PM**



Course Structure

- Four more lectures (possibly more)
- Two projects:
  - Internet Router - 5.5 weeks
  - Design challenge - 4.5 weeks
- Milestone deliverables
- Meetings with instructors
- Documentation requirements
- Final presentation / demonstration
- *No Midterm or Final*

Lecture Schedule

- *Wed, April 4th:*
  - **P4 Language Overview**
- *Monday, April 9th:*
  - **Learn about P4→NetFPGA and how to use it**
- *Wed, April 11th:*
  - **Intro to working with FPGAs**
- *Monday, April 16th:*
  - **P4 Applications - Guest lecture**
- Others TBD

Teams

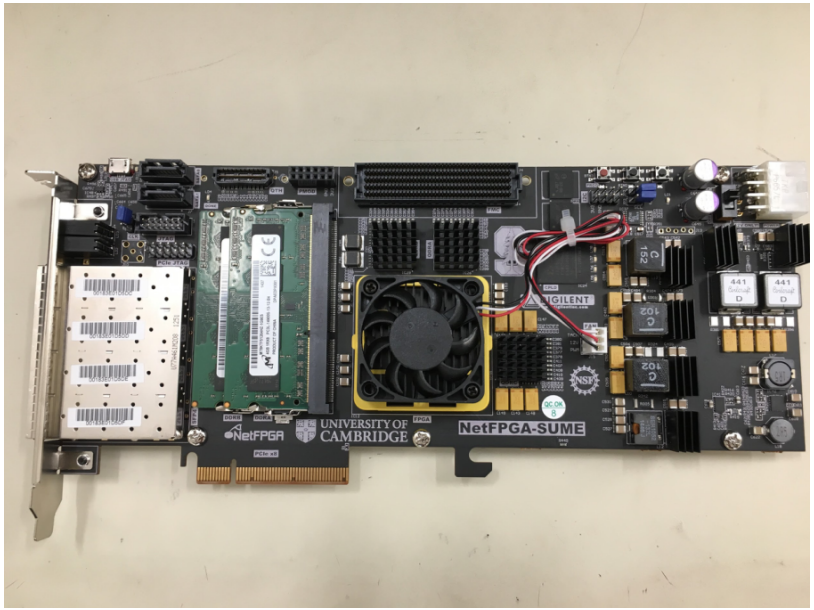
- Teams of 2, instructors will assign
  - Data-plane developer
  - Control-plane developer
- Indicate preferences on applications
- Each team assigned a development machine

Lab

- Gates 325
- One machine per team
  - One NetFPGA SUME board
  - One dual-port 10G NIC
- Key Access
- Sharing hardware policy

Hardware

NetFPGA SUME



Dual Port 10G NIC

Tools

Data-Plane:

Control-Plane:

Deliverables

- Getting Started - 1st deliverable, **due Friday April 6th, by 11:59 PM**
- Intro Assignments
- Router
  - **Baseline tests (milestone)**
  - **Interoperability test proposal (entire class)**
  - **Interoperability test + final solution**
- Design Challenge Project
  - **Proposal**
  - **Status Report**
  - **Final Presentation + Demonstration**

Review & Submission Process

- Github used extensively
- Each team develops a fork of the starter code repo
- Submission:
  - Tag specific commits – explain who did what
- Instructor Feedback:
  - Github issues
  - Pull Requests (possibly)
- Final submission:
  - Pull Request to starter code repo

Documentation Requirement

- Design Document as README file in project directory
- Clearly explain design decisions
- Weekly design document reviews (Fridays)
  - Check progress
  - Offer feedback
  - Organize your thoughts and plans
  - Good practice

Meetings with Instructors

- Total of four 15-min meetings
- Two before interoperability test - router project
- Two after interoperability test - advanced features project
- Purpose: similar to design document reviews, more face-to-face :)
- Sign up on starter code wiki page:
  - https://github.com/CS344-Stanford-18/P4-NetFPGA-CS344-18/wiki/Team-Meeting-Slots

Interoperability

- You prove to us that your routers are interoperable
- Develop a plan early! Submit plan for approval
- Will mostly use unused lecture slots to meet (do not register for another class in the same slot)
- Discuss on Piazza

Collaboration Policy

- Each team must do their own work
- No code sharing!
- No reusing code from online sources.
- We will use tools to compare against previous years and online sources.
- Do ***not*** misuse sudo privileges

Final Presentation / Demonstration

- A presentation on your design challenge project
- 15 min + 5 min questions
- Wednesday June 13th @ 3:30PM

Grading Breakdown

Marks are awarded to an individual (I) or the team (T).

Points	Item	Description
10 (I)	Participation	This will be a subjective judgement by us based on aspects such as our interaction with you in regular meetings, your team's documentation on who did what, and by watching the online discussions.
5 (T)	Interoperability	Your router should interoperate correctly with the routers from all other teams. We will conduct an interoperability test session to verify interoperability.
50 (T)	Functionality	The code deliverables
25 (T)	Documentaion	The weekly documentation checks
10 (T)	Presentation	Final presentation

Ask for help!

- Piazza
- Office hours
- Meetings with instructors
- Classmates

TF: Steve Ibanez

CA: Sarah Tollman

Prof: Nick McKeown

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