

Computer Networks

Introduction

Jianping Pan
Fall 2022

Q: How's your life in the last two years?

Computer Networks

Introduction

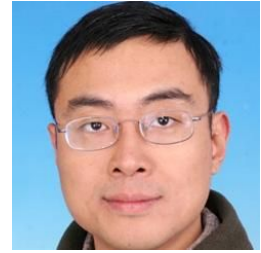
Jianping Pan
Fall 2022

*Q: How's your life in the last two years **if there was no Internet?***

About the course

- Computer Communications and Networks
 - lectures: Tue/Wed/Fri 9:30--10:20am, in ECS116
 - Our course website: <http://bright.uvic.ca>
 - “Fall 2022 CSC361”: lectures, labs, tutorials, resources, etc
 - prerequisites: *a message* from Undergrad Advisor...*
 - Algorithms and Data Structures: II (**CSC226**)
 - Computer Architecture (**CSC230** or CENG/ECE255)
 - Software Development Methods (**SENG265**)
 - ***strongly recommended!***
 - Introduction to Operating Systems (**CSC360**)

About the lecture instructor



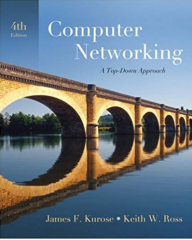
- Dr Jianping Pan
 - pan@uvic.ca
 - office hours: Mon 10am--12noon on Zoom
 - or by appointment
 - work experience
 - UVic prof, industry labs researcher, UWaterloo postdoc
 - redesigned CSc361 and its new lab in 2007/8 and 2020/1
 - research area
 - computer networks and distributed systems
 - <http://web.uvic.ca/~pan>

About the lab/tutorial instructors

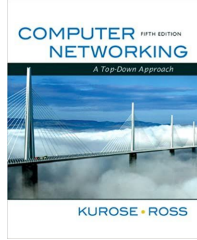
- Tutorial starts this Friday 1:30pm, **Sep 9, 2022!**
 - Tutorial instructor: Zhiming
- Lab starts from next week: M|T|W, Sep 12|13|14
 - Lab instructor: Zhiming, Amir, Yifeng
 - check <http://uvic.ca/WebTT> for your exact lab time
 - problems to register? Let me know!
 - if you have more flexibility, please consider to
 - trade a seat with those who have time conflict
 - but need to be official in the system (by cscadvisor)

* please respect all copyright regulations!

Course materials



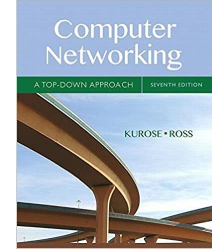
4th ed



5th ed



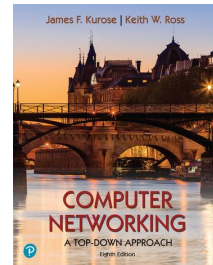
6th ed



7th ed

- Required textbook https://gaia.cs.umass.edu/kurose_ross/

- James F. Kurose and Keith W. Ross (K&R),
Computer Networking: A Top-Down Approach,
Addison Wesley, ***Fourth Edition or newer*** *.
 - *older than 4th edition NOT acceptable*
- what if you have other textbooks?
 - do get a copy of this book, better the newest (8th) edition



8th ed

- Explore further

- web links @ course website; O'Reilly's through UVic
- /., IETF, USENIX, ACM, IEEE, ..., and Google!

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* see textbook website for the table of contents difference between editions; toc-7ed on bright

Course schedule and topics

- First month
 - network architectures: mainly the Internet (**IPS**)
 - application layer: mainly **HTTP** and **DNS**
- Second month
 - transport layer: mainly **TCP** and **UDP**
- Third month
 - network layer: mainly **IP addressing** and **routing**
 - link layer: **logical link**, **media access** control
- See course website for details

Course evaluation

- One Written assignment (5%) as a prep for M1
 - out: Sep 16; due: Sep 23; returned: before Sep 30
- Three in-class Midterm exams (45%)
 - 15% each; detailed format TBD
 - on Oct 7, Nov 4 and Dec 5, 2022, respectively
- Three Programming assignments (35%)
 - 10%, 15% and 10% each, respectively
 - due: Sep 30, Oct 28 and Nov 25 in ***Python***
- Weekly Homework (10%) and Participation* (5%)

Our draft weekly schedule (1)

updated

Week Dates	Monday	Tuesday	Wednesday	Friday	Note
1 Sept 7 and 9			1-Intro	2-Overview Tutorial 1: Python	Get ready for lab
2 Sept 12-14 and 16	Lab 1: PicoLab	3-Access Network Lab 1: PicoLab	4-Backbone net Lab 1: PicoLab	5-Client/server Tutorial 2: P1	W1 out by Sept 16 P1 out by Sept 16
3 Sept 19-21 and 23	No Lab	6-Web and HTML Lab 2: HTTP	7-HTTP intro Lab 2: HTTP	8-HTTP advanced Tutorial 3: P1	W1 due: Sept 23 P1 design/coding
4 Sept 26--28	Lab 3: SWS	9-DNS intro Lab 3: SWS	a-DNS advanced Lab 3: SWS	<i>No Lecture</i> <i>No Tutorial</i>	W1 return by Sep 30 P1 due on Sep 30
5 Oct 3--5 and 7	Lab 4: DNS	UDP Lab 4: DNS	TCP intro Lab 4: DNS	M1 Tutorial 4: P2	M1 on Oct 7 P2 out by Oct 7
6 Oct 11--12 and 14	<i>No Lab</i>	TCP Cnx Mgmt <i>No Lab</i>	Flow Control <i>No Lab</i>	TCP flow control Tutorial 5: P2	P2 design done
7 Oct 18--20 and 22	Lab 5: TCP CMFC	Error Control Lab 5: TCP CMFC	TCP error control Lab 5: TCP CMFC	Congestion control Tutorial 6: P2	P2 code/test done

Our draft weekly schedule (2) *updated*

- All schedules tentative and subject to change

Week	Monday	Tuesday	Wednesday	Friday	Note
8 Oct 24--26 and 28	Lab 6: TCP FC	TCP CC basics Lab 6: TCP FC	TCP CC advanced Lab 6: TCP FC	Buffer for Month 2 Tutorial 7: P2	P2 due on Oct 28
9 Oct 30, Nov 1--2, 4	Lab 7: TCP CC	IP intro Lab 7: TCP CC	IP addressing Lab 7: TCP CC	M2 Tutorial 8: P2/P3	M2 on Nov 4 P3 out by Nov 4
10 Nov 8	<i>No Lab</i>	Routing algorithms <i>No Lab</i>	<i>No Lecture</i> <i>No Lab</i>	<i>No Lecture</i> <i>No Tutorial</i>	P3 design done
11 Nov 14--16 and 18	Lab 8: Addressing	Routing protocols Lab 8: Addressing	LLC protocols Lab 8: Addressing	MAC Tutorial 9: P3	P3 code/test done
12 Nov 21--23 and 25	Lab 9: Routing	Ethernet Lab 9: Routing	WiFi Lab 9: Routing	Interworking Tutorial 10: P3	P3 due on Nov 25
13 Nov 28--30; Dec 2 6	Lab 10: ARP	Buffer for Month 3 Lab 10: ARP	Term review Lab 10: ARP	Term buffer <i>No Tutorial</i>	M3 on Dec 6

Course policies

- See official course outline through brightspace
 - late assignments, marking appeals, etc
 - ***academic integrity: we treat it very seriously***
 - if you can find it by google, so do others in our DB too
 - accessibility, **accommodation**, etc
- No group assignments
 - collaboration/participation is encouraged
 - responsibility: your submitted work is yours
 - protect your own work too!
 - obligation: give credits to all referred materials

What is this course *really* about?

- It's about **FUN**
 - It's *Fun to Understand Networks*
- Why is it fun?
 - we're already using networks a lot everyday
 - it's really cool to know the things underneath
 - almost all computer systems now are networked
 - it's really important for EECS students to know networks
 - strong job market for network-proficient people
 - impress your next interviewer, or just your grandma
 - computer networks => network science
 - transport, social, biology, business, neural networks, etc

And things “not fun” too: e.g., Rogers

- April 19, 2021 across the country, 22 hours overall
 - vendor software upgrade (due to the **way** of deployment?)
 - “wireless calls, SMS and data services were down”
- July 8, 2022 nationwide, wireless and wired, few days
 - 12+ million customers directly affected: phone, TV and Internet
 - many more indirectly: financial, government services, etc
 - and even **9-1-1 emergency call** and **public alert** services
 - 6th of a 7-stage upgrade process for 2 years?
 - code update tested 5 times before the deployment?
 - equipment of **2** vendors behaving differently (on BGP filters)?
- Testimony to the Commons on July 25, 2022
 - separation of wireless and wired networks for \$250M?
 - partitioning of affected regional networks?
 - better code and deployment testing with AI for \$10B?



What's exciting in lectures?

- Now offered as a third-year networks course
 - to respond to the requests from students/employers
 - heavily redesigned from the original CSc450/550
 - the process started (by now) 16 years ago*
- Focusing on TCP/IP networking
 - how your home network works?
 - how the Internet works? and the things in between
- How can we make it more fun?
 - “Explore further” questions, also in labs too!
 - hands-on experience in labs and tutorials

More systems/networks courses!

- Wireless Mobile Networks (CSc463)
- ***Advanced Computer Networks (CSc466)***
 - overlay and peer-to-peer networking: **Fall 2022**
- Advanced Communication Networks (CSc467)
- **Networking degree option in CS/SENG**
 - and directed studies, honor's/technical projects, etc
- Real-time/Embedded Systems (CSc460)
- Multimedia Systems (CSc461)
- Distributed Systems (CSc462)

What's exciting in lab? now PicoLab

- Old CSc361 Lab platform (2007--2017)
 - Minimized OpenWRT
 - Running on Linksys WRT54GL
 - Dual cabled to stock Ubuntu Linux in ECS360
- Intermediate Lab platform (2018--2020)
 - MiniNet in VirtualBox in ECS360 (or student laptop)
 - Also moved from C to Python
- **PicoNet**: *new* CSc361 Lab platform (2020--)
 - **PicoHub** = PicoNet + Docker + JupyterLab in Cloud
 - **PicoLab** = Dockerized PicoNet in a (K)VM in ECS360



A sneak peak: more this Friday

```
Terminal 1
-----+
| PicoNet 0.01 (Alpha) |
+-----+
+ Hosts:                +
+ h1 (h1-eth0 192.168.1.100) +
+ h2 (h2-eth0 10.10.1.100)  +
+ r (eth0 192.168.1.1, eth1 10.10.1.1) +
+ dns (172.16.1.1)         +
+-----+
root@h1:/home/jovyan# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
3: h1-eth0@if2: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default qlen 1
000
    link/ether e6:e1:d3:6b:13:25 brd ff:ff:ff:ff:ff:ff link-netns r
    inet 192.168.1.100/24 scope global h1-eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::e4e1:d3ff:fe6b:1325/64 scope link
        valid_lft forever preferred_lft forever
root@h1:/home/jovyan#

Terminal 2
-----+
| PicoNet 0.01 (Alpha) |
+-----+
+ Hosts:                +
+ h1 (h1-eth0 192.168.1.100) +
+ h2 (h2-eth0 10.10.1.100)  +
+ r (eth0 192.168.1.1, eth1 10.10.1.1) +
+ dns (172.16.1.1)         +
+-----+
root@h2:/home/jovyan# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
5: h2-eth0@if4: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default qlen 1
000
    link/ether 9e:c8:44:63:31:17 brd ff:ff:ff:ff:ff:ff link-netns r
    inet 10.10.1.100/24 scope global h2-eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::9cc8:44ff:fe63:3117/64 scope link
        valid_lft forever preferred_lft forever
root@h2:/home/jovyan#

Terminal 3
-----+
| PicoNet 0.01 (Alpha) |
+-----+
+ Hosts:                +
+ h1 (h1-eth0 192.168.1.100) +
+ h2 (h2-eth0 10.10.1.100)  +
+ r (eth0 192.168.1.1, eth1 10.10.1.1) +
+ dns (172.16.1.1)         +
+-----+
root@h3:/home/jovyan# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: r-eth0@if3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default qlen 10
00
    link/ether 46:57:9c:77:34:30 brd ff:ff:ff:ff:ff:ff link-netns h1
    inet 192.168.1.1/24 scope global r-eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::4457:9cfe:77:3430/64 scope link
        valid_lft forever preferred_lft forever
4: r-eth1@if5: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default qlen 10
00
    link/ether 2e:21:a0:a8:6c:6b brd ff:ff:ff:ff:ff:ff link-netns h2
    inet 10.10.1.1/24 scope global r-eth1
        valid_lft forever preferred_lft forever
    inet6 fe80::2c21:a0ff:fe8a:6c6b/64 scope link
        valid_lft forever preferred_lft forever
7: r-eth2@if6: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default qlen 10
00
    link/ether aa:fd:8f:91:b7:9e brd ff:ff:ff:ff:ff:ff link-netnsid 2
    inet 172.16.1.1/24 scope global r-eth2
        valid_lft forever preferred_lft forever
    inet6 fe80::a8fd:8fff:fe91:b79e/64 scope link
        valid_lft forever preferred_lft forever
root@h3:/home/jovyan#

jovyan@piconet: ~
-----+
| PicoNet 0.01 (Alpha) |
+-----+
+ Hosts:                +
+ h1 (h1-eth0 192.168.1.100) +
+ h2 (h2-eth0 10.10.1.100)  +
+ r (eth0 192.168.1.1, eth1 10.10.1.1) +
+ dns (172.16.1.1)         +
+-----+
(base) jovyan@piconet:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
6: host-nat@if7: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default qlen
1000
    link/ether da:5f:20:84:83:9c brd ff:ff:ff:ff:ff:ff link-netns r
    inet 172.16.1.2/32 scope global host-nat
        valid_lft forever preferred_lft forever
44: eth0@if45: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default
    link/ether 02:42:ac:11:00:02 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 172.17.0.2/16 brd 172.17.255.255 scope global eth0
        valid_lft forever preferred_lft forever
(base) jovyan@piconet:~$
```

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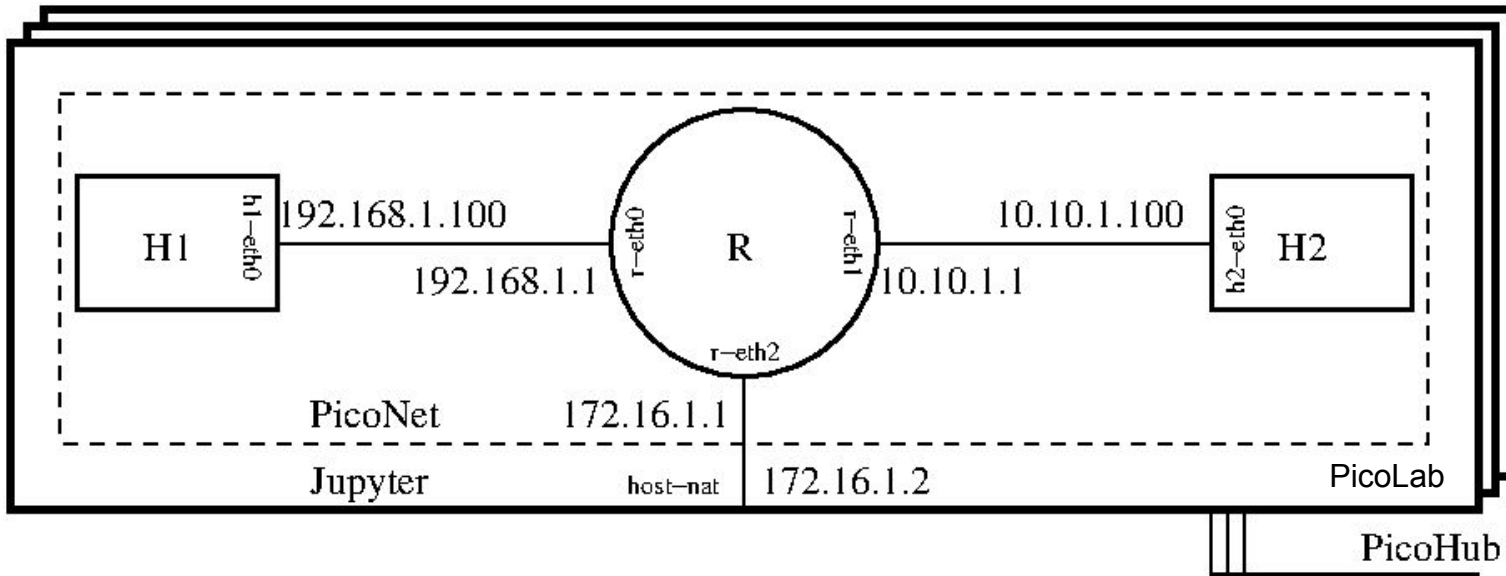
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* in ecs360, after you log in, open a terminal, and type in "picolab"; more <http://tinyurl.com/ecs360>

PicoNet in a nutshell

- H1: the client computer (connected to R through h1-eth0)
- R: the router (connected to H1 and H2 thru r-eth0 and r-eth1, respectively)
 - Also connected through r-eth2 to the PicoNet host (host-nat) and then to the Internet
- H2: the server computer (connected to R through h2-eth0)



Too easy for you?

- We have something more challenging for you!
 - <http://www.csc.uvic.ca/competitions> and UVic records
 - ACM ICPC (programming contest): 3rd in US/Canada PacNW
 - ACM SRC (student research competition)
 - BCNET BIC/DMC (network applications): 1st place in BC
 - IEEE Extreme (online programming competition): 3rd in Canada
 - IEEE ComSoc: Communication technology changing the World
 - NSERC USRA (undergrad research award, CPR only)
 - UVic JCURA (undergrad research award, all students)
 - and many more ...
 - **UVic (Competitive) Programming Club**
<https://oac.uvic.ca/programmingclub/>

NSERC USRA

- Undergraduate Student Research Awards
 - awards allocated to our dept every year
 - deadline for Spring/Summer 2022 to come soon
 - get a taste of doing research
 - a good experience before graduation, going to graduate school, or committing to a research career
 - impress your next job interviewer
 - can be used as Co-op work term as well
 - see some networks projects or propose yours
 - <http://www.cs.uvic.ca/~pan/usra>

Too challenging for you?

- We are here to help
 - **brightspace discussion forums**
 - get help and help others!
 - *CSC consultant office (now mainly for 1xx courses)*
 - *2nd floor, ECS building*
 - your lab/tutorial instructors
 - make the best out of your lab and tutorial hours
 - your lecture instructor
 - in class, during office hours, or by appointment
- A quick google (not Ctrl-C/V) often can help too!

Suggested approaches

- Before lectures
 - read required sections in textbook; preview video
 - write down your questions
- Attend lectures
 - take notes, ask questions, interact with demos
- After lectures
 - explore further, get help and help others (not code)
- Attend labs and tutorials
 - start assignments early according to weekly schedule!

Common issues/mistakes

- “The slides are too ***brief!***”
 - slides intended to be a **brief guide map**
 - a lot of details, discussion, questions and answers only appear in class and on black or whiteboard
 - **attending lectures/tutorials/labs is essential**
- “I will do my assignments on the due date”
 - simple fact: you cannot finish or even start it
 - understand the spec, design, implement, improve...
 - **starting early to progress every week is essential**

Course Representative

- We need **six** Course Reps!
 - roughly one for each lab section
 - interact with the students attending this course
 - voice their concerns
 - meet with lecture/lab/tutorial instructors regularly*
 - help us do better
- AAA: aggregate, anonymize, amplify
 - we do encourage direct students feedback too!

Assignment 0

- Due on this Friday, September 9, 2022, 5pm
- Through brightspace
 - Assignments -> A0
 - things you already know about computer networks
 - things you want to know more about computer networks
 - what and how's your home Internet access?
 - how can we help you and others better?
 - interested in ACM/IEEE, NSERC USRA, JCURA?
 - any issues with logistics? volunteer for course rep?
 - set your brightspace profile picture consistently
 - let me know you as well! for reference letters later etc

Next lecture

- An overview on computer networks

- read K&R4: Computer Networking

- Chapter 1 (except 1.6)

- Video tutorials (see Bright->Forums)

- * Post your questions on brightspace discussion forums if any

- * Youtube playlist:

- <https://www.youtube.com/playlist?list=PLXDX4vxbgW0D3nXlxxNPehChW5iQG1iJC> “This tutorial by Prof. Anand Seetharam from Binghamton University covers the basic concepts of computer networking - the application layer, the transport layer, the network layer and the link layer.”

- Video lectures by Prof Jim Kurose

- * http://gaia.cs.umass.edu/kurose_ross/

- * Youtube playlist pending

