Welcome to

Networking Technologies for Cloud Computing

USTC-CYSC6402P Instructor: Chi Zhang Fall 2020



Part 1: outline

- Course overview
 - What this course is about?
 - And-what it is not about?
 - My teaching/your learning strategies
 - Why you should (or not) take this course?
 - Administrative aspects
 - How does this course operate?

This course

- is instructed by 张驰
 - email: chizhang@ustc.edu.cn
 - office: 907, West Wing of Sci. & Tech. Building
- is TA'd by 李旭东
 - email: xudongli@mail.ustc.edu.cn
 - office: 913, West Wing of Sci. & Tech. Building
- takes place Sat, 19:30-21:00 pm, in IAT Future Center, Lecture Hall 3
- comes with office hours:
 - currently, Sat, 14:00-17:00 pm or by appointment

Course website

- https://github.com/342623lxd/cloud-computing
- The course website is the official source for:
 - lecture slides,
 - assignments,
 - supplemental material,
 - etc.
- Password: USTC60
- Please check the course website frequently!
- Course email: cloudc2018@163.com
 - 课程作业通过此email提交,提交后请确认收到TA回复

WeChat Group for CC-Fall-2020

- 请务必加入微信群
 - 所有通知和讨论以微信群为准!
 - 请将自己在微信群中的昵称改为真实"姓名+学号"



Who are you?

- Please send us (cloudc2018@163.com) a registration email after today's class
- Registration email example:

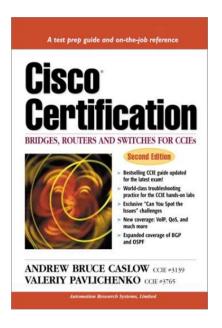
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主题: Registration+张三
姓名: 张三
学号: XXXXXXXXX
导师: 李四
院系和年级: 6系、研一
研究方向: XXX
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Course goal

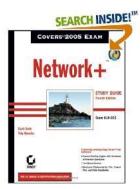
- Learn how the network works
 - Protocols/systems, and how they interact
 - Reasoning behind its design decisions
- Learn how to do networking/system research
 - How to use research tools
 - Perform conference-quality research project
 - Appreciate what is good research (problem selection, methodology, presentation)

What this course is NOT about

- an introduction to networking/cloud computing
 - We will not cover TCP/IP basics, etc.
- certification course/job training course
 - I will not teach you how to configure specific pieces of networking equipment











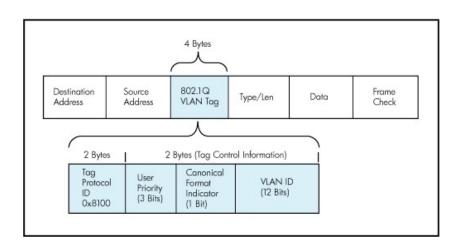
How universities teach networking?

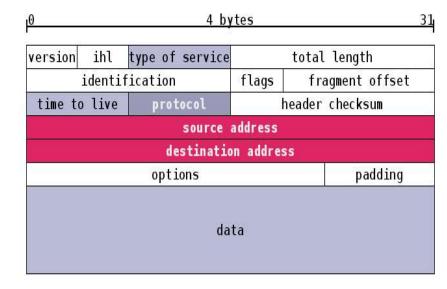
- We are teaching (arti)facts or history, not principles
 - Network design not based on formal principles
- We are teaching a big bag of protocols
 - No intellectual framework for networking
 - And let you try to make sense of it
- We build great myths of spin about how what we have done is the only way to do it to the point that our universities now teach the flaws to students (and professors and textbook authors) who don't know better.—John Day

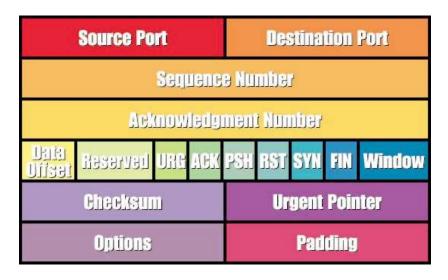
A plethora of protocol acronyms

SNMP		WAP	SIP			PΧ	
LLDP	FTP	UD		PP	P	MA	AC .
OSPF	RTP		IC	MP	IMAP	IGMP	HIP
PIM	RED	BGP	нтті		ARP	ECN	N
RIP		l	IP	MPLS	TCF)	RTCP
	SMT		TSP		BFD	CIDR	
NNTP	SA	CK		TLS	NAT		STUN
D	NS		SSH			DHCP	
POP	V	LAN	LISP	VTP	TFTP		LDP

A heap of header formats





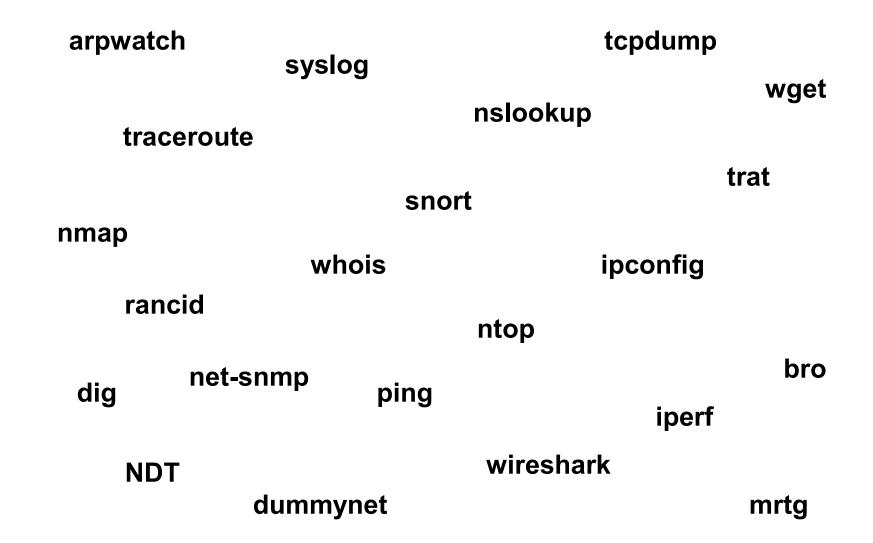


Name	Value				
HTTP Status Code: HTTP/1.1 200 OK					
Date:	Thu, 27 Mar 2008 13:37:17 GMT				
Server:	Apache/2.0.55 (Ubuntu) PHP/5.1.				
Last-Modified:	Fri, 21 Mar 2008 13:57:30 GMT				
ETag:	"358a4e4-56000-ddf5c680"				
Accept-Ranges:	bytes				
Content-Length:	352256				
Connection:	close				
Content-Type:	application/x-msdos-program				

A big bunch of boxes

Load Label **Switch** Router balancer **Switched** Router Scrubber Repeater **Gateway Bridge** Intrusion Route **Detection** Deep Reflector **Packet System** Inspection **DHCP Packet** server **Firewall** shaper **NAT** Hub **Packet** sniffer DNS WAN Base **Proxy** server accelerator station

A ton of tools



What do students say?

- "In my college networking class I fell asleep at the start of the semester when the IP header was on the screen, and woke up at the end of the semester with the TCP header on the screen."
- "Networking is all details and no principles."
- "All are ad hoc deployments. More of a domain than a discipline."
- "Networking is an opportunistic discipline."
- "Networking papers are strange. They have a lot of text."

This course: a new approach

- Defining the problem is a big part of the challenge
 - Recognizing a need, formulating a well-defined problem is at least as important as solving the problem.
 - Rather than studying "layer-by-layer", we will look at different problems in networking
- The best way to understand networking is to first try to solve the design issues yourself
 - Then the current solution will make a lot more sense
 - We will study different approaches to the same problem and debate their merits

This course: a new approach

- I care most about teaching the fundamental concepts
 & principles
 - I am a theory guy. I hate details!
 - Scott Shenker@Berkeley: Don't let the tail wag the dog...
- You will have to learn the current design
 - You will end up with a mixture of the "big picture" and "current design details"

High-level course topics

- It's a big field, so we will focus on just a few topics
- The exact schedule will develop as the semester goes on



Below are a set of high-level topics that we can expect to discuss

- Cloud Computing Survey
- Future Internet Architecture & Software Defined Networking (SDN)
- Datacenter Networks and Protecols Bitcoin & Blockchain
- Wireless Networking & Edge Computing
- Security and Privacy Issues

Prerequisites

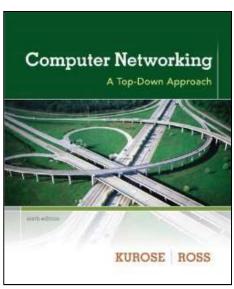
- undergraduate level courses in Computer Networks or Network Security
- or familiar with research literature in these areas

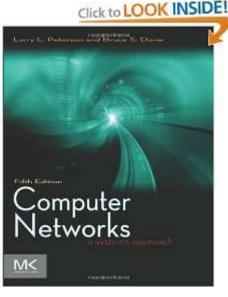
 If you want to refresh your background, the following books might be useful

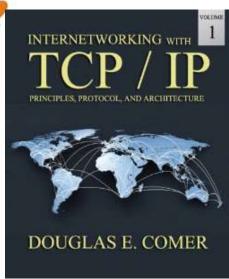
Recommended background reading

- 谢希仁, 计算机网络(第6版), 电子工业出版社, 2013.
- James F. Kurose & Keith W. Ross, Computer Networking: A Top-Down Approach (6th Edition), Pearson, 2012.
- Larry L. Peterson & Bruce S. Davie, Computer Networks: A Systems
 Approach (5th Edition), Morgan Kaufmann, 2011.
- Dauglas E. Comer, *Internetworking With TCP/IP, Volume 1:* Principles Protocols, and Architecture (6th Edition), Pearson, 2013.





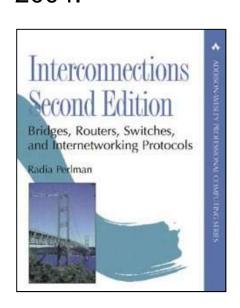


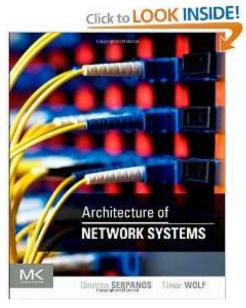


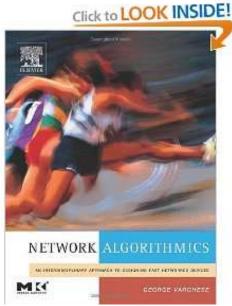
Recommended background reading

- Radia Perlman, *Interconnections: Bridges, Routers, Switches, and Internetworking Protocols* (2nd Edition), Addison-Wesley, 1999.
- Dimitrios Serpanos & Tilman Wolf, Architecture of Network Systems, Morgan Kaufmann, 2011.

George Varghese, Network Algorithmics: An Interdisciplinary
 Approach to Designing Fast Networked Devices, Morgan Kaufmann,
 2004.

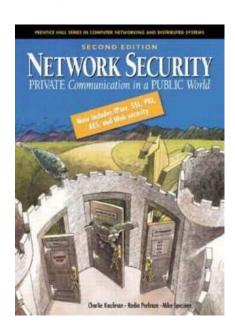


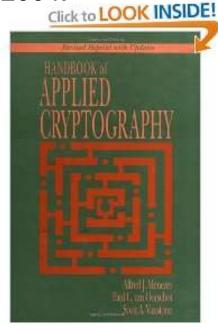


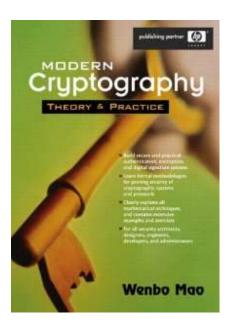


Recommended background reading

- Charlie Kaufman, Radia Perlman & Mike Speciner, Network
 Security: Private Communication in a Public World (2nd Edition),
 Prentice Hall, 2002.
- Alfred J. Menezes, Paul C. van Oorschot & Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 1996.
- Wenbo Mao, Modern Cryptography: Theory and Practice, Prentice Hall, 2003. Kaufmann, 2004.







Textbook

- NO textbook!
- ONLY piles of research papers!





Course structure

- Lectures and discussions
- Readings and presentations

Course structure: lectures

- Overview of background material
- Overview of research literature
 - The classics
 - The challenges
 - The latest
- Presentation, discussion and debate about the research papers
 - I'll lead some presentations
 - Sign up for papers you'd like to present

Course structure: readings

- Study in group of size ≤ 4
 - find your partners now
 - MBA method: learn from each other
- Read the required papers before class
 - read, summarize, criticize, compare and present research papers
 - discuss in your group
 - discuss with me in my office hours
- Submit paper reviews (for at least 5 papers) individually
- Each group should prepare at least one presentation in class
 - I will help you in my office hours

Grading policy

- Readings & submitting paper reviews: 40%
- Presentation (with your group): 40%
- Class participation: 20%
- No roll call in class
- I reserve the right to assign grades based on the overall performance
- This is a graduate-level course
 - Grade is less important than what you learn
 - But I will try my best to be fair

Is this the right class for you?

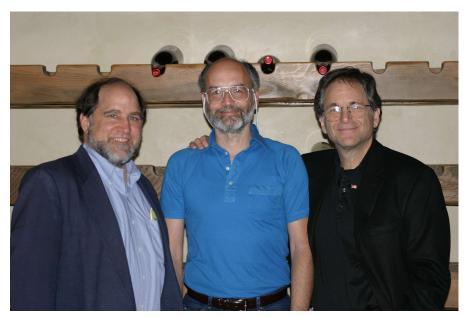
- Want to understand the "why" of networking?
 - Not just looking for definitions and techniques
- Want to DO networking research?
 - Willing to actively participate in class, discussion and research
- Willing and able to do a lot of reading?
 - 30+ papers

Four golden lessons

- ...start doing research, and pick up what I needed to know as I went along...no one knows everything, and you don't have to.
- ...go for the messes—that's where the action is.
- ...forgive yourself for wasting time...If you want to be creative, then you will have to get used to spending most of your time not being creative.
- ...learn something about the history of science, or at a minimum the history of your own branch of science.

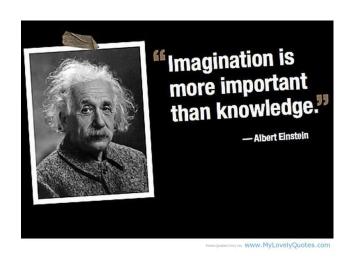
—Steven Weinberg, Nobel Prize Winner

Shamir's choice: reading & thinking



RSA: Rivest, Shamir & Adleman







How to read a paper: principles

- Read critically. Be suspicious.
 - Right problem? Reasonable assumptions? Flaws in reasoning?
- Read creatively. More positive thinking.
 - It is always easier to tear down than to build up.
 - What are the good ideas? What you would do next?
- Write as you read
 - Low-level notes
 - High-level notes: summarization
- Compare the paper to other works
 - Backward references
 - Forward references
 - Surveys
 - Related conferences & journals

How to read a paper: methods

- Multi-pass reading
 - Give yourself a limited time budget to force yourself to keep moving
- Always "top down"
 - First: abstract, introduction, conclusion
 - Rest of paper if necessary
- Keshav's three stage approach
 - Read quickly in 5-10 minutes
 - Read with greater care; ignore proofs
 - Deconstruct paper; question all assumptions

A checklist for this course

- What is the main topic of the article?
- What was/were the main issue(s) the author said they want to discuss?
- Why did the author claim it was important?
- How does their work build on other's work, in the author's opinion?
- What simplifying assumptions does the author claim to be making?
- What did the author do?
- How did the author claim they were going to evaluate their work and compare it to others?
- What did the author say were the limitations of their research?
- What did the author say were the important directions for future research?

Always top down

Pramod Khargonekar's advice

Preparing for a 5 minutes/15 minutes/30 minutes/

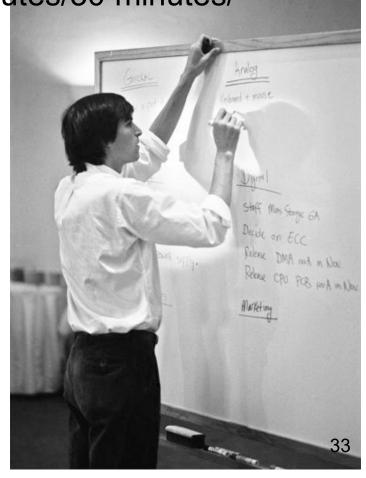
.../2 hours' talk



Kalman



Khargonekar

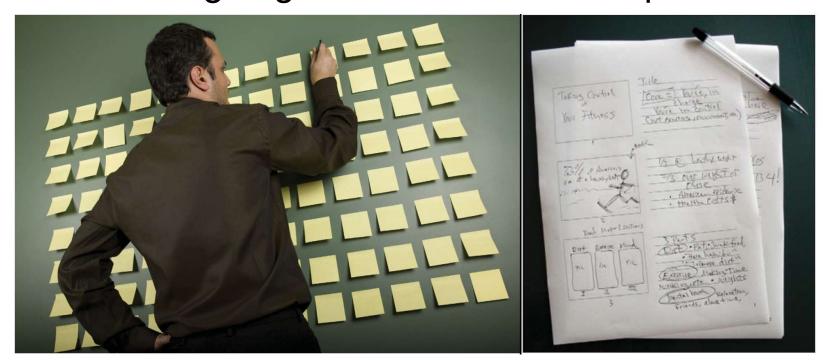


Every paper tells a story

- what is the "elevator pitch" of your story?
 - elevator pitch = summary that is short enough to give during an elevator ride
- the story is not what you did, but rather
 - what you show, new ideas, new insights
 - why interesting, important?
- why is the story of interest to others?
 - universal truths, hot topic, surprises or unexpected results?
- First of all, know your story!

Write top down

- computer scientists (and most human beings) think this way!
- state broad themes/ideas first, then go into detail
- even when going into detail ... write top down!



Put yourself in place of the audience

- Quote attributed to Richard Varga: A good research presentation should guarantee
 - everybody can understand 25%
 - only experts can understand 50%
 - the speaker can understand 75%
 - nobody can understand the left 25%
- In my class, a good paper presentation should guarantee
 - everybody can understand 25%
 - students in the classroom can understand at least 60%
 - Group members can understand at least 80%
 - the speaker and I can understand 100%

Put yourself in place of the audience

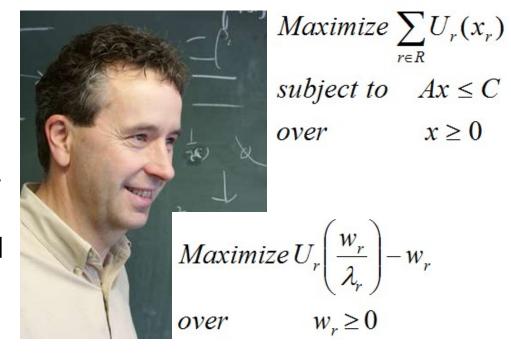
- Who is your primary audience?
 - Prepare for audience, not for yourself
- Audience shouldn't have to work
 - Won't "dig" to get story, understand context, results
- No one (not even your mother) is as interested in this topic as you
 - So you had better be (or appear) interested
- Using examples with visual aids!
- Feel nerves? Practice, practice, practice

Application domain for theory

- Algorithms and data structures
- Control theory
- Queuing theory
- Optimization theory
- Game theory and mechanism design
- Formal methods
- Information theory
- Cryptography
- Programming languages
- Graph theory

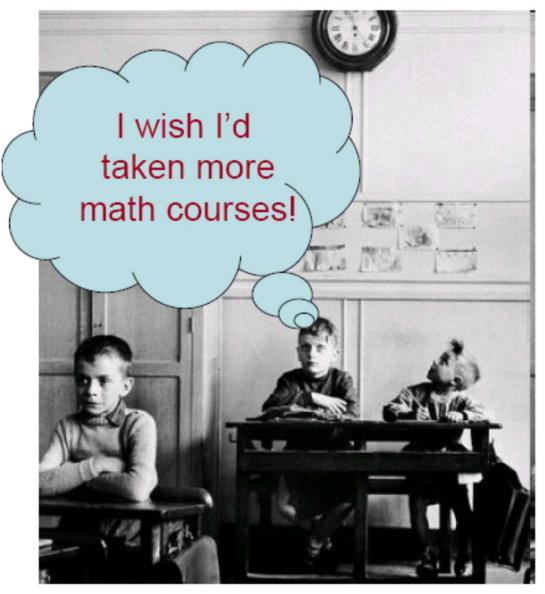
Theoretical research

- Prof. Frank Kelly @ University of Cambridge
- Papers:
 - Fluid model for a network operating under a fair bandwidth-sharing policy, Annals of Applied Probability, 2004.
 - Rate control in communication networks: shadow prices, proportional fairness and stability, Journal of the Operational Research Society, 1998.



$$\begin{aligned} & \textit{Maximize} \ \sum_{r \in R} w_r \log x_r \\ & \textit{subject to} \quad Ax \leq C \\ & \textit{over} \qquad x \geq 0 \end{aligned}$$

Math, math, math



Take math courses!

- Every math course I've taken has been valuable
- Won't have time later
- Research fields draw increasingly on math as they mature
- Theory is timeless!

An exercise in entrepreneurship

- Identify a need or desirable capability
 - Whether previously known or not
- Invent a new feature or system that provides it
- Determine how it fits in the existing network
- Build and/or evaluate your solution
- Pitch or sell the problem and solution to others
 - Whether to investors or a program committee
- Bask in glory, or lick your wounds

System research



- Prof. Scott Shenker @ UC Berkeley
- Erdos in Networking
- SDN, SDN, SDN, ...



System research

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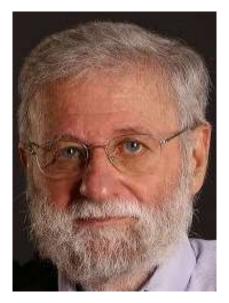
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A story about mastering complexity

- 1985: Don Norman visits Xerox PARC
- At start of his talk on UI design he asks:
 - "Who in the audience drives a stick shift?"
- After most of the audience raises their hands, he looks sternly out over the crowd and says:
 - "None of you should ever design a user interface"



Academics get paid for being clever, not for being right.

— Don Norman

2014 Summer @ Alibaba



Ali's 11.11 Sales Miracle





Ali's 11.11 Sales Miracle

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- 2013年双11成交总额350亿元/天
- 2013年中国零售总额600亿元/天
- 峰值交易量15320笔/秒
- 全中国银行的电子交易处理能力6600笔/秒





Wiping-off IOE

• I = IBM小型机

O = Oracle数据库



TEACHERS OPEN THE DOOR. YOU ENTER BY YOURSELF.

- CHINESE PROVERB

Welcome to CYSC6402P and have fun!