CSE 570S: Recent Advances in Networking

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These slides and audio/video recordings are available on-line at:

http://www.cse.wustl.edu/~jain/cse570-15/

Overview

❑ Goal of this Course

❑ Contents of the course

❑ Tentative Schedule

❑ Project

❑ Grading

Goal of This Course

❑ Recent networking topics

❑ Topics of interest to industry

❑ Comprehensive course – cover many topics

❑ Data Center Networking, Virtualization, Software Defined Networking, Big Data, Cloud Computing, Internet of Things

❑ Breadth First

❑ Graduate course: (Advanced Topics)
  ⇒ Lot of independent reading and writing
  ⇒ Project/Survey paper (Research techniques)

Objectives: What You Will Learn?

Top 10 Topics in Networking

1. Data Center Networking
2. Virtualization
3. Cloud Computing
4. Big Data
5. OpenFlow
6. Software Defined Networking (SDN)
7. Network Function Virtualization (NFV)
8. Internet of Things (IoT)
9. Software Defined Intelligence
10. NETCONF and YANG

Data Center Networking

1. How are data centers networks different from those in homes or offices?

2. What are the standards for data center layout?

3. How have Ethernet and other protocols been changed to accommodate data centers?

4. How and why connect multiple data centers on a single Ethernet?

Virtualization

1. Why virtualize?
2. How are servers virtualized?
3. How is storage virtualized?
4. What networking components are virtualized and how?
5. What are new networking standards related to virtualization?
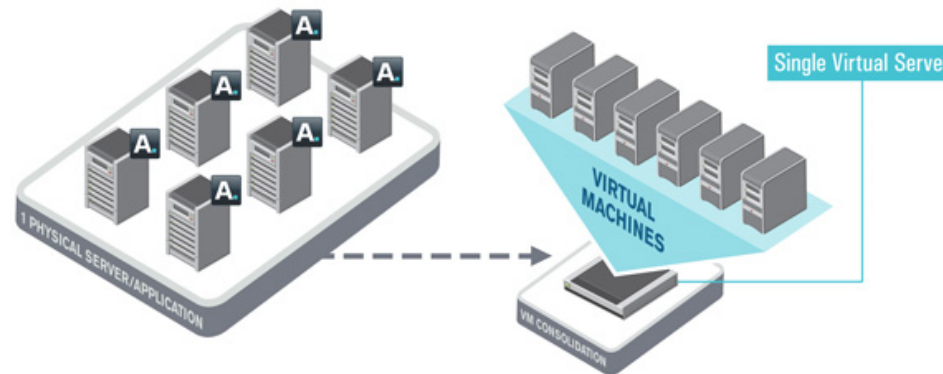
Cloud Computing

1. What is cloud computing?
2. What are different types of cloud services?
3. How is different from other forms of computing: Grid, Cluster, ..
4. What new technologies are required to enable cloud computing?
5. What is fog (vs. cloud) computing?

Big Data

1. What is big data?
2. Why sudden surge of interest in big data?
3. What are the key technologies for big data?
4. How can networking help in solving big data problems?
5. What is the relationship between clouds and big data?

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OpenFlow

1. Planes of Networking

2. What is OpenFlow protocol and why it was needed

3. OpenFlow Operation

4. OpenFlow Evolution

5. Current Limitations and Issues

Software Defined Networking

1. What is software defined networking?
2. Why is the industry running to adopt this new technology so fast?
3. What new facilities are enabled by SDN?
4. What is the difference between SDN and OpenFlow?
5. What are different flavors of SDN?
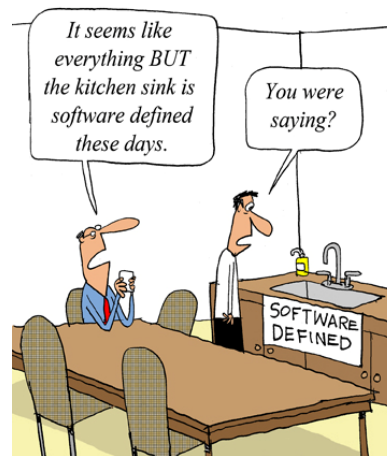
Network Function Virtualization (NFV)

1. What is NFV?

2. NFV and SDN Relationship

3. ETSI NFV ISG Specifications

4. Concepts, Architecture, Requirements, Use cases

5. Proof-of-Concepts and Timeline

[Source: LightReading]

Internet of Things

1. What is so unique about Internet of Things (compared to current Internet)?

2. What are the new IEEE/IETF protocols for IoT?

3. What technologies are required for Web of Things (WoT)?

4. What are different kinds of things: M2M, Sensors, RFID, …

5. How clouds can help IoT?

Software Defined Intelligence

1. What is machine learning?

2. Sample machine learning techniques

3. What can network operators do with machine learning?

4. Sample applications

NETCONF and YANG

1. Why is NETCONF needed?

2. What can we do with NETCONF?

3. Message formats

4. What is YANG data modeling language

Non-Goals

❑ The following current issues are not covered in this course:

➢ Wireless developments – 4G, 5G, Pico Cell, Femto cell
(Will be covered in CSE 574 – Wireless Networking)

➢ Security – Are clouds secure?
Security and Privacy issues of IoT.
(Will be covered in CSE 571 – Network security)

❑ These issues require background not covered in CSE 473.

Reading Material

1. Technical Papers

2. Industry whitepapers

3. Standards documents

4. Wikipedia, http://en.wikipedia.org/wiki/

5. Books

Reference Books

- G. Santana, "Data Center Virtualization Fundamentals," Cisco Press, 2013, ISBN:1587143240

- V. Josyula, M. Orr, and G. Page, "Cloud Computing: Automating the Virtualized Data Center," Cisco Press, 2012, 392 pp., ISBN: 1587204347

- H. Saboowala, M. Abid, S. Modali, "Designing Networks and Services for the Cloud: Delivering business-grade cloud applications and services," Cisco Press 2013, ISBN:1587142945

- K. Hess, A. Newman, "Practical Virtualization Solutions: Virtualization from the Trenches," Prentice Hall, 2009, ISBN:0137142978

- C. Poelker, A. Nikiti, "Storage Area Networks For Dummies," For Dummies, 2009, ISBN:9780470385135

- J. Hurwitz, et al., "Big Data for Dummies," Wiley, 2013, ISBN:978-1-118-50422-2

- S. Azodolmolky, "Software Defined Networking with OpenFlow," Packt Publishing, October 2013, 152 pp., ISBN:978-1-84969-872-6

Reference Books (Cont)

- T. Nadeau and K. Gray, "SDN," O'Reilly, 2013, 384 pp, ISBN:978-1-449-34230-2B

- O. Hersent, et al., "The Internet of Things: Key Applications and Protocols," Wiley, 2013, 344 pp., ISBN: 9781119994350

- H. Chaouchi, "The Internet of Things: Connecting Objects," Wiley, Jun 2010, 288 pp., ISBN: 9781848211407

- H. Zhou, "The Internet of Things in the Cloud: A Middleware Perspective," CRC Press, 2013, 365 pp., ISBN: 9781439892992

Note: All of the above books are available online to WUSTL students via **Safari Books**

Networking Courses at WUSTL

❏ CSE 473s: Introduction to Computer Networks

❏ CSE 570S: Recent Advances in Networking

❏ CSE 571S: Network Security

❏ CSE 573s: Protocols for Computer Networks

❏ CSE 574s: Wireless and Mobile Networking

❏ CSE 777s: Research Seminar in Networking

CSE 570S	CSE 571s	CSE 573s	CSE 574s	CSE 777s
CSE 473s				
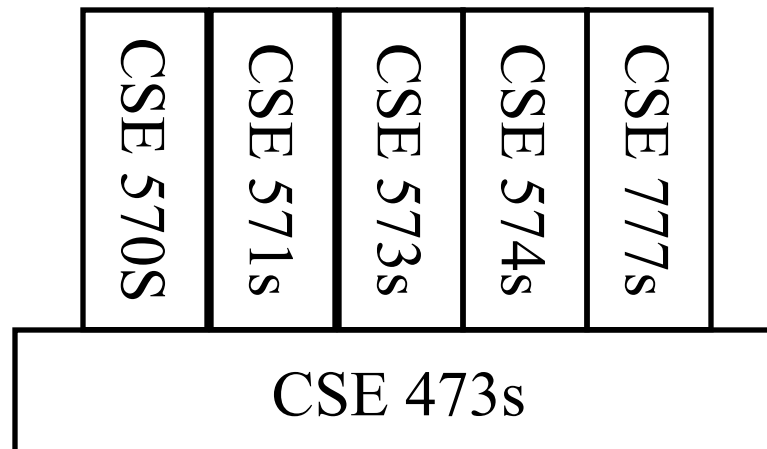
Prerequisite: CSE473S

❑ Protocol Layers: ISO/OSI reference model

❑ TCP/IP protocol stack

❑ LAN Addressing: Unicast vs. multicast, Local vs. Global

❑ Extended LANs: Hubs vs. Bridges vs. Routers vs. Switches

❑ VLANs

❑ IPv4 and IPv6 Address: Public vs. Private Addresses

❑ Subnets

❑ Address Resolution Protocol (ARP)

❑ Internet Control Message Protocol (ICMP)

❑ TCP connection setup, Checksum (pseudo-header), Slow start

❑ TCP vs. UDP

❑ Hypertext Transfer Protocol (HTTP)

Tentative Schedule

Date	Day	Topic	
8/24/2015	Monday	Course Overview	
8/26/2015	Wednesday	Networking Trends	
8/31/2015	Monday	Data Center Network Topologies	1
9/2/2015	Wednesday		2
9/7/2015	Monday	*Labor Day Holiday*	
9/9/2015	Wednesday	Data Center Ethernet	1
9/14/2015	Monday	Server Virtualization	1
9/16/2015	Wednesday	Storage Virtualization	1
9/21/2015	Monday	Carrier Ethernet	1
9/23/2015	Wednesday		2
9/28/2015	Monday	**Exam 1**	

❑ Note: Exam dates are fixed.

Tentative Schedule (Cont)

Date	Day	Topic	
9/30/2015	Wednesday	Application Delivery Networking	1
10/5/2015	Monday	Virtual Bridging	1
10/7/2015	Wednesday		2
10/12/2015	Monday	Big Data	1
10/14/2015	Wednesday		2
10/19/2015	Monday	Networking Issues for Big Data	1
10/21/2015	Wednesday	LAN Extension and Virtualization	1
10/26/2015	Monday		2
10/28/2015	Wednesday	OpenFlow	1
11/2/2015	Monday	**Exam 2**	

❑ Note: Exam dates are fixed.

Tentative Schedule (Cont)

Date	Day	Topic	
11/4/2015	Wednesday	OpenFlow	2
11/9/2015	Monday	Software Defined Networking	1
11/11/2015	Wednesday	Network Function Virtualization	1
11/16/2015	Monday	Internet of Things	1
11/18/2015	Wednesday	Software Defined Intelligence	
11/23/2015	Monday	NETCONF and YANG	1
11/25/2015	Wednesday	*Thanksgiving Holiday*	
11/30/2015	Monday		2
12/2/2015	Wednesday	**Final Exam**	

❑ Note final exam is in the last class before the reading period.

Projects

❑ Hands-on project or a survey paper related to the 6 topics of the course

❑ Some hands-on project and survey topics will be assigned.
Some you can suggest for approval.

❑ Average 6 Hrs/week/person on project + 9 Hrs/week/person on class

❑ Recent Developments: Last 2 to 4 years
⇒ Not in books

❑ Will be published on my website,
Better ones may be submitted to magazines or journals

Project Requirements

❑ Comprehensive Survey:
Technical Papers, Industry Standards, Products

❑ No copyright violations:
$\Rightarrow$ You need to re-draw all figures
$\Rightarrow$ You need to summarize all ideas in your *own* words
$\Rightarrow$ Cannot copy any part of text or figure unmodified
$\Rightarrow$ Short quotes ok
$\Rightarrow$ Any unmodified figures need permissions
Any infringement will result in forfeiture of grades even after graduation.

Example of Projects

- Performance Comparison of Big Data Analysis using Hadoop in Physical and Virtual Servers

- A Survey of Balloon Networking Applications and Technologies

- Recent Information-Centric Networking Approaches

- Recent Advances in Named Data Caching and Routing

- Naming in the Internet of Things

- Survey of Recent Research Progress and Issues in Big Data

- Survey of Recent Research Issues in Data Center Networking

- SDN: Development, Adoption and Research Trends

- Semantic Web Core Technologies

Example of Projects

❑ A Survey of Networking Issues in Smart Grid

❑ The Effects of the Green Networking Initiative on Power Consumption

❑ IP Based Smart Services

❑ Survey of Next-Generation Broadband Aggregation Networks

❑ Routing and Security in Vehicular Networking

See http://www.cse.wustl.edu/~jain/cse570-13/index.html for a sample of previous projects reports

You can suggest a topic for approval or select from a list of topics that will be provided.

Project Schedule

Mon 10/05   Topic Selection

Mon 10/12   References Due

Mon 10/26   Outline Due

Mon 11/16   Final Paper Due -> Peer reviewed

Mon 11/23   Reviews Returned

Mon 11/30   Revised Report Due

Office Hours

❑ Monday/Wednesday:1 PM to 2 PM

❑ Office: Bryan 523

❑ Teaching Assistant:

➢ TBD

Grading

❑ Exams (Best of 2 mid terms + Final) 60%

❑ Class participation   5%

❑ Homeworks   15%

❑ Project   20%

Frequently Asked Questions

❑ Yes, I do use "curve". Your grade depends upon the performance of the rest of the class.

❑ One 8.4x11 sheet allowed in the exam. Class handouts, books not allowed. Time limited.

❑ Exams consist of numerical as well as multiple-choice (true-false) questions.

❑ There is negative grading on incorrect multiple-choice questions. Grade: +1 for correct. -1/(n-1) for incorrect.

❑ Everyone including the graduating students are graded the same way.

Homework Submission

❑ All homeworks are due on the following Monday at the beginning of the class unless specified otherwise.

❑ Any late submissions, if allowed, will *always* have a penalty.

❑ All homeworks should be submitted in hardcopy unless specified otherwise

❑ All homeworks are identified by the class handout number.

❑ All homeworks should be on a separate sheet.
Your name should be on every page.

❑ Please write CSE571 in the subject field of all emails related to this course.

❑ Use word "Homework" in the subject field on emails related homework. Also indicate the homework number.

Homework Grading

❑ Grading basis: Method + Correct answer

❑ Show how you got your answer

  ➢ Show intermediate calculations.

  ➢ Show equations or formulas used.

  ➢ If you use a spreadsheet, a statistical package, or write a program, print it out and turn it in with the homework.

  ➢ For Excel, set the print area and scale the page accordingly to fit to a page. (See Page Setup)

Quizzes

❑ There may be a short 5-minute quiz at the beginning of each class to check if you have read the topics covered in the last class.

Summary
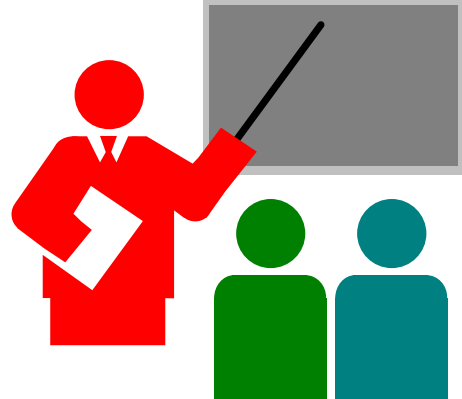
- ❑ Goal: To prepare you for the current job market in networking

- ❑ Teach you how to keep up with the latest in networking

- ❑ There will be a significant amount of self-reading and writing

- ❑ Get ready to work hard

Google Search Modifiers

- filetype:pdf, doc, ppt, pptx
- site:wustl.com
- intitle:trend
- inurl:trend
- allintitle:Networking Trends
- Allinurl:
- " " $\Rightarrow$ Exact Phrase
- OR
- AND
- + $\Rightarrow$ Must include
- - $\Rightarrow$ Not include
- ~X $\Rightarrow$ X or similar
- * $\Rightarrow$ Wildcard

Project Homework 1

❑ Search web pages, books, and journal articles from IEEE XPlorer, ACM Digital Library, MOBIUS, Safari books, ILLIAD at Olin Library for **one** of the following topics:

1. Networking Trends
2. Data Center Networking
3. Network Virtualization
4. Cloud Computing
5. Software Defined Networking
6. Big Data
7. Internet of Things

❑ On the web try the following search points:

➢ http://library.wustl.edu/findart.html
➢ http://library.wustl.edu/fulltext/
➢ http://scholar.google.com
➢ http://books.google.com
➢ http://dl.acm.org/

Project Homework 1 (Cont)

- ➤ http://www.scirus.com/srsapp/
- ➤ http://searchnetworking.techtarget.com/bestWebLinks/
- ❑ Ignore all entries dated 2010 or before. Also ignore all entries that do not indicate topic or similar words in the title. List others in the following format (up to 5 each):
    - ➤ Author, "Title," publisher, year, ISBN. (for 5 books)
    - ➤ "Title," URL [One line description] (for 5 web pages)
    - ➤ Author, "Title," source (for 5 technical/magazine articles)
- ❑ For the books, include whether the book is available at WUSTL, MOBIUS, Safari, or ILLiad
- ❑ Serially number the references and submit electronically to jain@wustl.edu. The mail should have a subject field of "CSE 570S Project Homework 1" (Please note the subject carefully. Do not any other characters in the subject). Your answers should be the content of the message and not in an attachment.
- ❑ Make a list of other interesting search points and share in class.

Common Mistakes in Project Homework #1

❑ Not indicating where the book can be found in WUSTL

❑ Listing books/Magazines/journals that have little to do with the topic – may show up in search engines because of a minor mention of the topic or words

❑ Web Pages – No one line descriptions

❑ Incomplete bibliographic data for journal articles. Need volume, issue, year, pages.

❑ Missing journals. Need names of journals dealing with the topic chosen.

Quiz 0: Prerequisites

True or False?

T F

☐ ☐ Subnet mask of 255.255.255.254 will allow 254 nodes on the LAN.

☐ ☐ Time to live (TTL) of 8 means that the packet can travel at most 8 hops.

☐ ☐ IP Address 128.256.210.12 is an invalid IP address

☐ ☐ Network Address Translator (NAT) connects a private network to Internet.

☐ ☐ DHCP server is used for automatic assignment of IP address

☐ ☐ DNS helps translate a name to a MAC address

☐ ☐ Port 80 is used for FTP.

☐ ☐ IPv6 addresses are 32 bits long.

☐ ☐ New connection setup message in TCP contains a syn flag.

☐ ☐ 192.168.0.1 is a public address.

☐ ☐ Spanning tree algorithm is used to find a loop free path in a layer 2 network.

Marks = Correct Answers _____ - Incorrect Answers _____ = _____

Student Questionnaire

- Name: _____
- Email: _____
- Phone: _____
- Degree: _____ Expected Date: _____
- Technical Interest Areas:

  _____

  _____

- Prior networking related courses/activities:

  _____

  _____