

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/cse570-13/>



- ❑ 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)

Virtualization of Life

- ❑ Internet ⇒ Virtualization



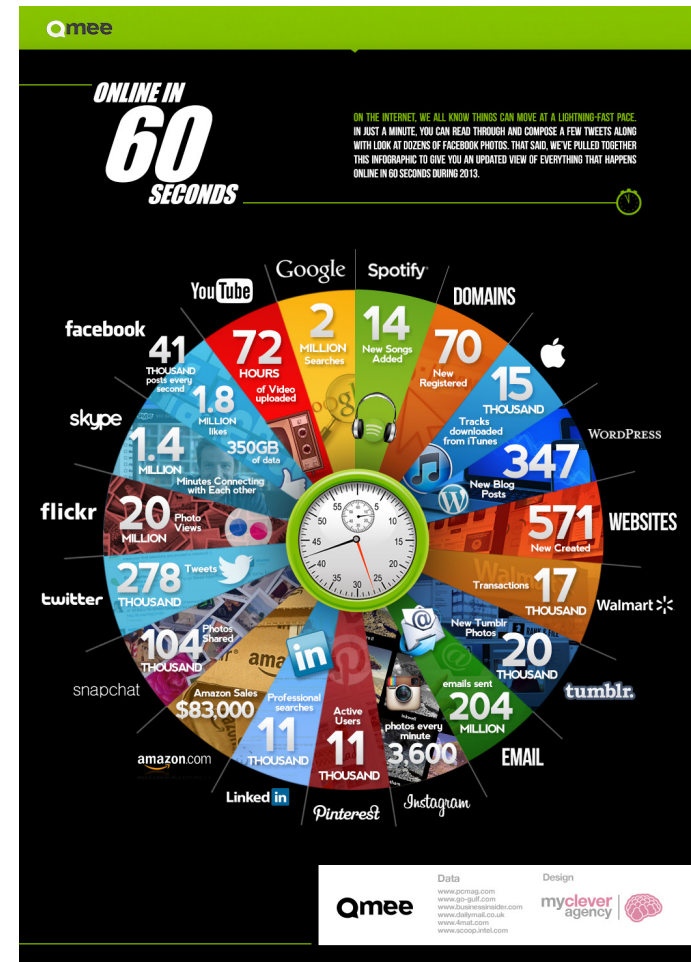
- ❑ No need to get out for
 - Office
 - Shopping
 - Entertainment
 - Education

- ❑ Virtual Workplace
- ❑ Virtual Shopping
- ❑ Virtual Education
- ❑ Virtual Sex
- ❑ Virtual Computing

What Happens on the Internet in 60 seconds?

□ Every Minute:

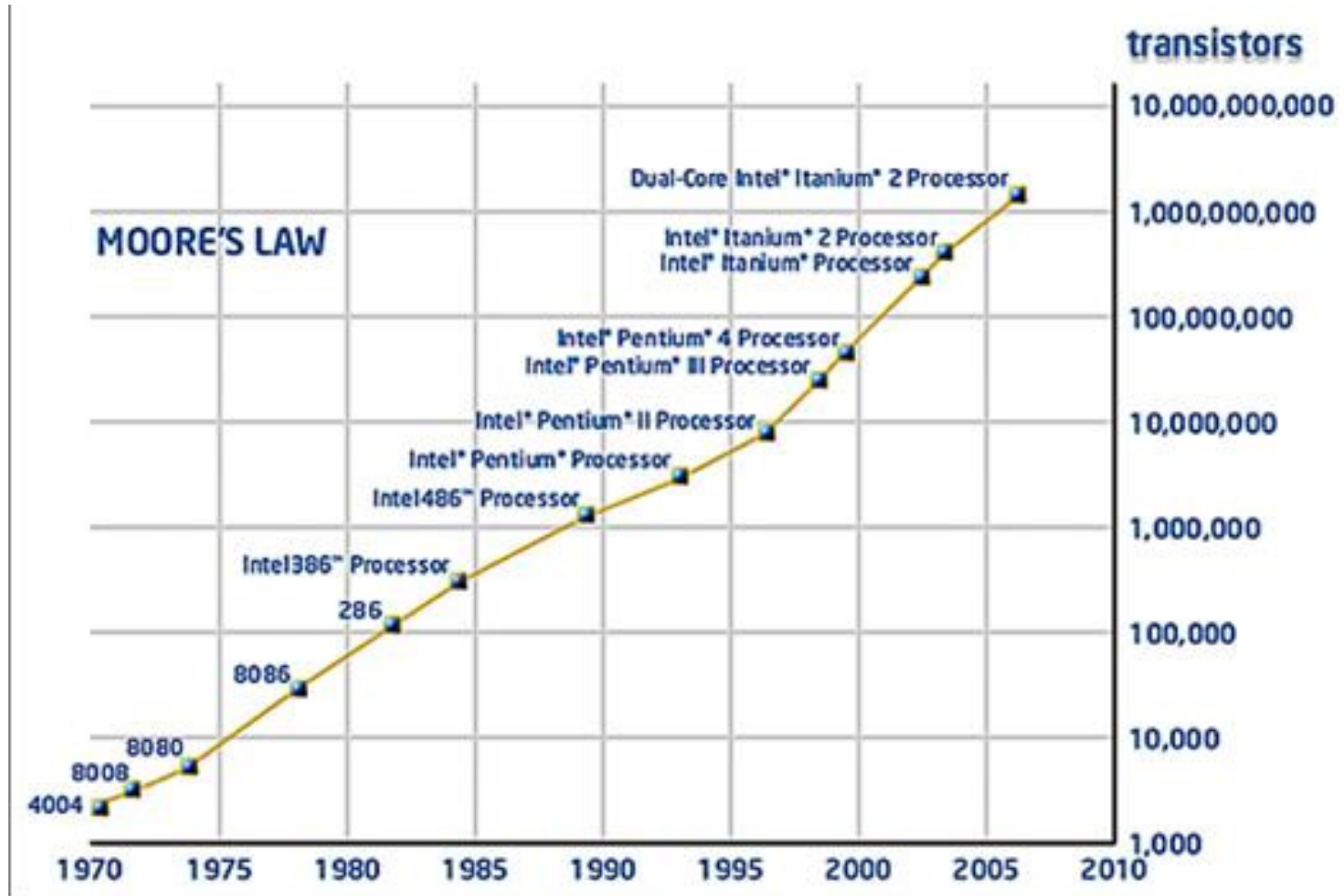
- 204 Million emails
- 2 Million searches on Google
- 350 GB of data to Facebook
- 72 hrs of video to YouTube
- 270,000 tweets
- 15000 songs from iTunes



Source: Qmee, "What happens on-line in 60 seconds," <http://blog.qmee.com/qmee-online-in-60-seconds/>
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Processor Growth: Moore's Law



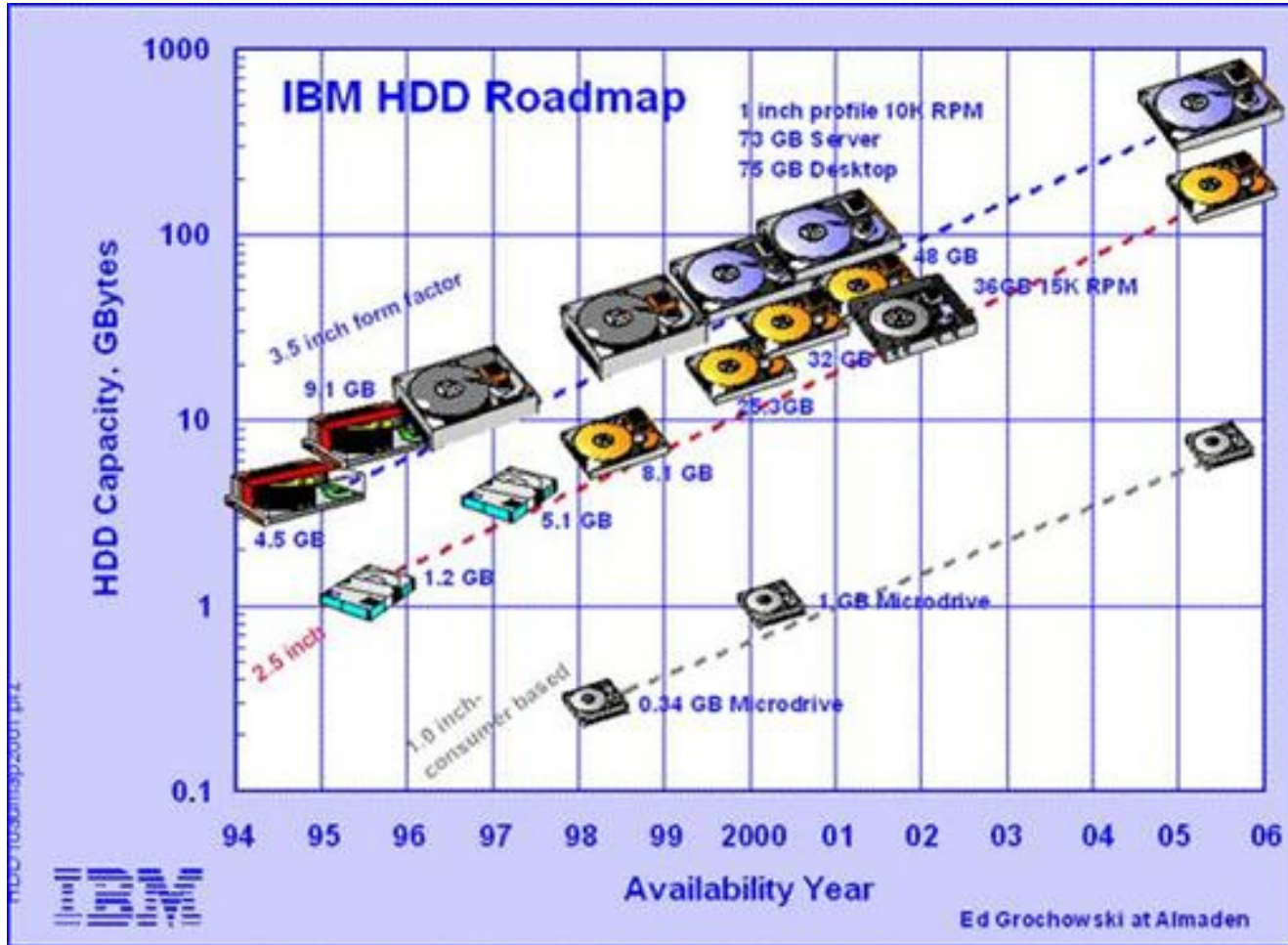
Ref: <http://www.intel.com/content/www/us/en/silicon-innovations/moores-law-technology.html>

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Storage Capacity



Ref: <http://www.deepspare.com/wp-data-loss.html>
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Clouds and Mobile Apps

- ❑ August 25, 2006: Amazon announced EC2
⇒ Birth of Cloud Computing in reality
(Prior theoretical concepts of computing as a utility)
- ❑ *Web Services To Drive Future Growth For Amazon* (\$2B in 2012, \$7B in 2019)
- Forbes, Aug 12, 2012
- ❑ June 29, 2007: Apple announced iPhone
⇒ Birth of Mobile Internet, Mobile Apps
 - Almost all services are now mobile apps: Google, Facebook, Bank of America, ...
 - Almost all services need to be global (World is flat)
 - Almost all services use cloud computing



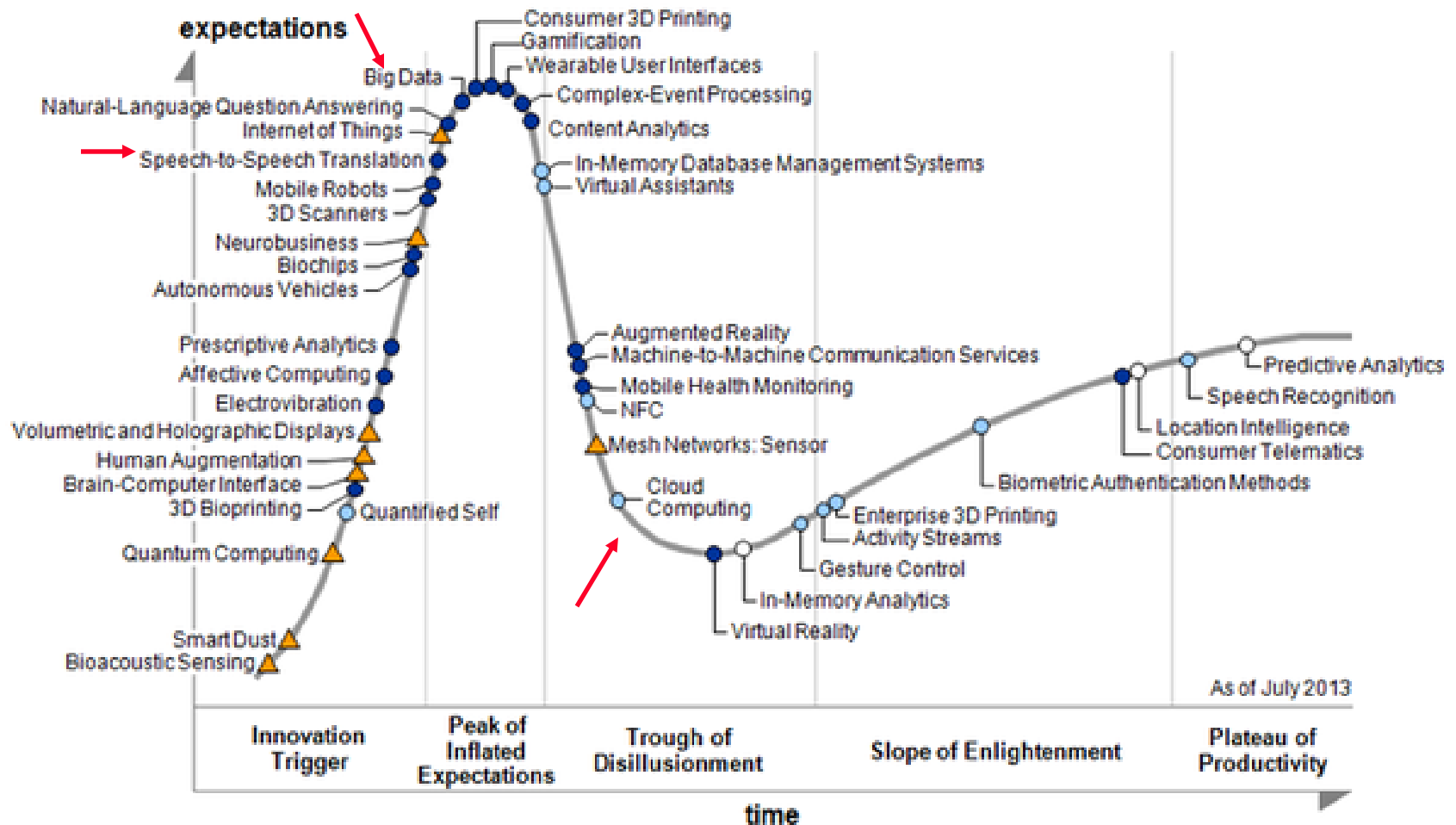
Networks need to support efficient service setup and delivery

Cisco Visual Networking Index

1. 2012 **mobile** data traffic was 885×10^{15} B/month.
12X the size of the entire global Internet in 2000 (75 PB/mth).
Will be 10×10^{18} B in 2017.
2. Mobile **video** traffic was 51% of the mobile traffic.
Will be 2/3 by 2017.
3. A **smart phone** generates 50X traffic of a basic phone.
Will be 2.7 GB/mth by 2017.
4. **4G** connections generate 19X the traffic of a non-4G
5. Usage per **Android** phone is higher than that per iPhone
6. 3.6 B Internet users in 2017 up from 2.3B in 2012
7. 19 B networked devices in 2017 up from 12 B in 2012
8. 1.4×10^{21} B Internet traffic in 2017 up from 0.5×10^{21} B in 2012.

Ref: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2012–2017, Feb 6, 2013,
, http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

Gartner Hype Cycle 2013



Plateau will be reached in:

○ less than 2 years ● 2 to 5 years ● 5 to 10 years ▲ more than 10 years ⊗ obsolete before plateau

Ref: <http://www.zdnet.com/gartners-2013-emerging-technologies-hype-cycle-focuses-on-humans-and-machines-7000019564/>

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Objectives: What You Will Learn?

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

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. Why connect multiple data centers by 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?

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. How is SDN different from Network Function Virtualization (NFV)?
5. What is the difference between SDN and OpenFlow?
6. What are different flavors of SDN?

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?

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?

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

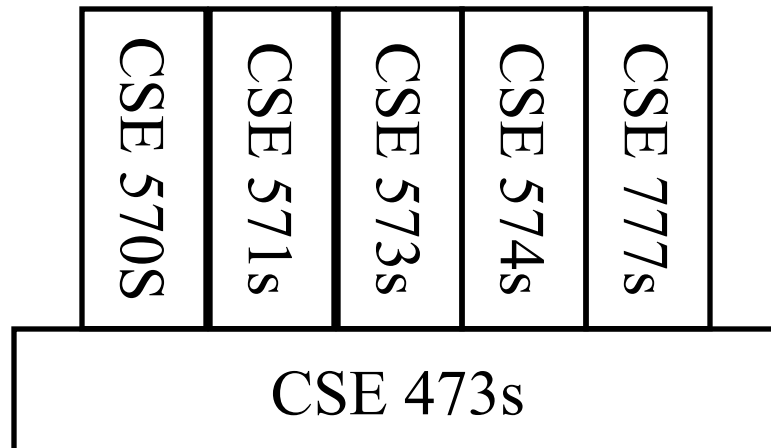
Reference Books

Partial List:

1. G.A.A. Santana, "Data Center Virtualization Fundamentals," Cisco Press, 2013, ISBN:1587143240,
2. K. Hwang, J. Dongarra, G.C. Fox, "Distributed and Cloud Computing," Morgan Kaufmann 2011, ISBN:0123858801
3. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective," CRC Press, 2012, ISBN:1439892997

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



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	
8/28/2013	Wednesday	Course Overview	
9/2/2013	Monday	<i>Labor Day Holiday</i>	
9/4/2013	Wednesday	Data Center Networking	1
9/9/2013	Monday		2
9/11/2013	Wednesday		3
9/16/2013	Monday	Network Virtualization	1
9/18/2013	Wednesday		2
9/23/2013	Monday		3
9/25/2013	Wednesday		4
9/30/2013	Monday	Exam 1	

Note: Exam dates are fixed.

Tentative Schedule (Cont)

Date	Day	Topic	
10/2/2013	Wednesday		5
10/7/2013	Monday	Big Data	1
10/9/2013	Wednesday		2
10/14/2013	Monday		3
10/16/2013	Wednesday		4
10/21/2013	Monday	Cloud Computing	1
10/23/2013	Wednesday		2
10/28/2013	Monday		3
10/30/2013	Wednesday		4
11/4/2013	Monday	Exam 2	

□ Note: Exam dates are fixed.

Tentative Schedule (Cont)

Date	Day	Topic	
11/6/2013	Wednesday	Software Defined Networking	1
11/11/2013	Monday		2
11/13/2013	Wednesday		3
11/18/2013	Monday		4
11/20/2013	Wednesday		5
11/25/2013	Monday	Internet of Things	1
11/27/2013	Wednesday	<i>Thanksgiving Holiday</i>	
12/2/2013	Monday		2
12/4/2013	Wednesday		3
12/9/2013	Monday		4
12/11/2013	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

Example of Projects

- ❑ Setting up and using a Hadoop cluster for big data analysis?
- ❑ Setting up and using a cloudlet using OpenStack
- ❑ Setting up and using an SDN controller and a few OpenFlow switches
- ❑ A survey paper on recent developments in SDN.
- ❑ A survey paper on recent developments Data Center Networking.
- ❑ A survey paper on recent developments Network Virtualization.

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

Project Schedule

- Mon 10/07 Topic Selection
- Mon 10/14 References Due
- Mon 10/28 Outline Due
- Mon 11/18 Final Paper Due -> Peer reviewed
- Mon 11/25 Reviews Returned
- Mon 12/02 Revised Report Due

Homework Submission

- ❑ All homeworks are due on the following Monday unless specified otherwise.
- ❑ Any late submissions, if allowed, will ***always*** have a penalty.
- ❑ 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.
- ❑ All homeworks are identified by the class handout number.
- ❑ All homeworks should be on a separate sheet. Your name should be on every page.

Office Hours

- ❑ Monday/Wednesday: 1 PM to 2 PM
- ❑ Office: Bryan 523

- ❑ Teaching Assistant:
 - Paras Tiwari, Bryan 410, pbtiwari@wustl.edu
 - Office Hours: Thursday/Friday 2-3PM

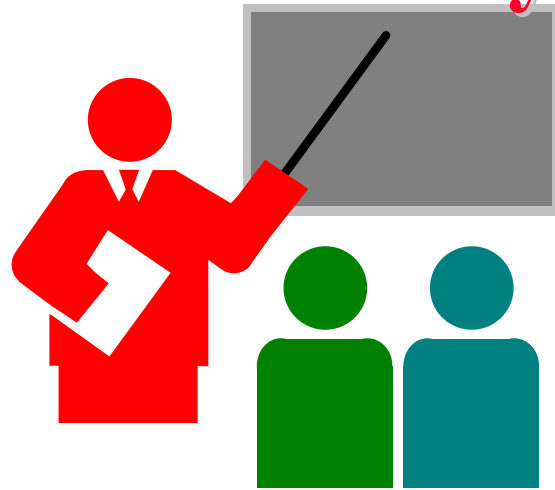
Grading

- ❑ 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.
- ❑ All homeworks are due on the following Monday unless specified otherwise.
- ❑ Any late submissions, if allowed, will *always* have a penalty.
- ❑ One 8.4x11 sheet allowed in the exam. Book 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.

Summary



- ❑ Goal: To prepare you for the current job market 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:
- ❑ “ “ ⇒ Exact Phrase
- ❑ OR
- ❑ AND
- ❑ + ⇒ Must include
- ❑ - ⇒ Not include
- ❑ ~X ⇒ X or similar
- ❑ * ⇒ 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 2008 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@cse.wustl.edu. The mail should have a subject field of “**CSE 570S 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.

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:

