OPERATING SYSTEMS

RONG ZHENG

Disclaimer: Many materials used in the slides are adopted from those of other colleagues

GOAL OF THIS COURSE

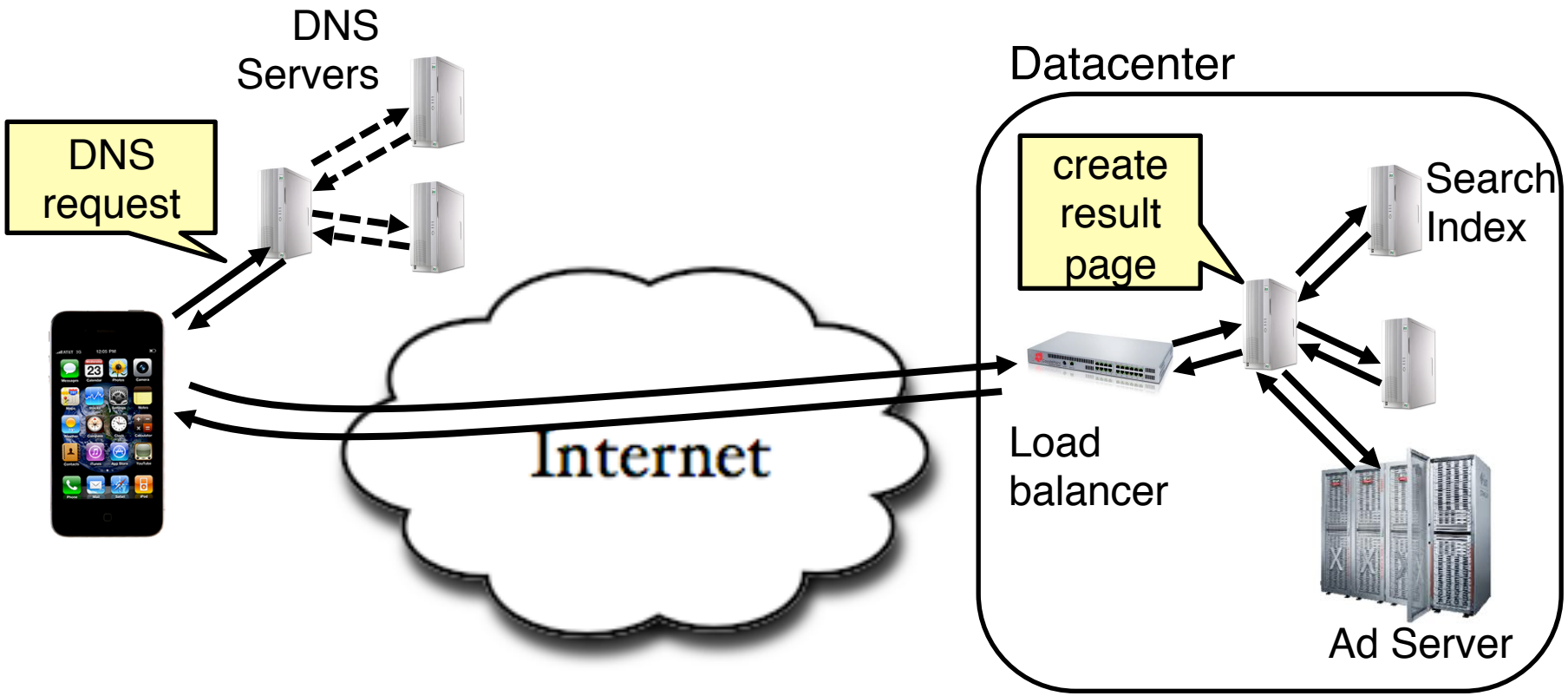
Learn how “systems” work

Main challenges in building systems

Principles of system design, i.e., how to address these challenges

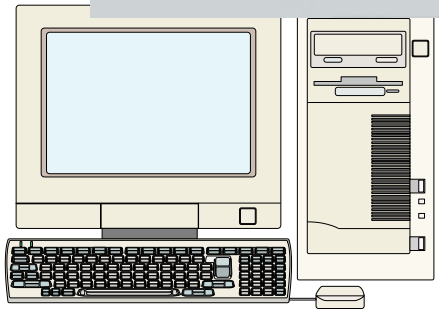
Learn how to apply these principles to building systems

EXAMPLE: WHAT'S IN A SEARCH QUERY?

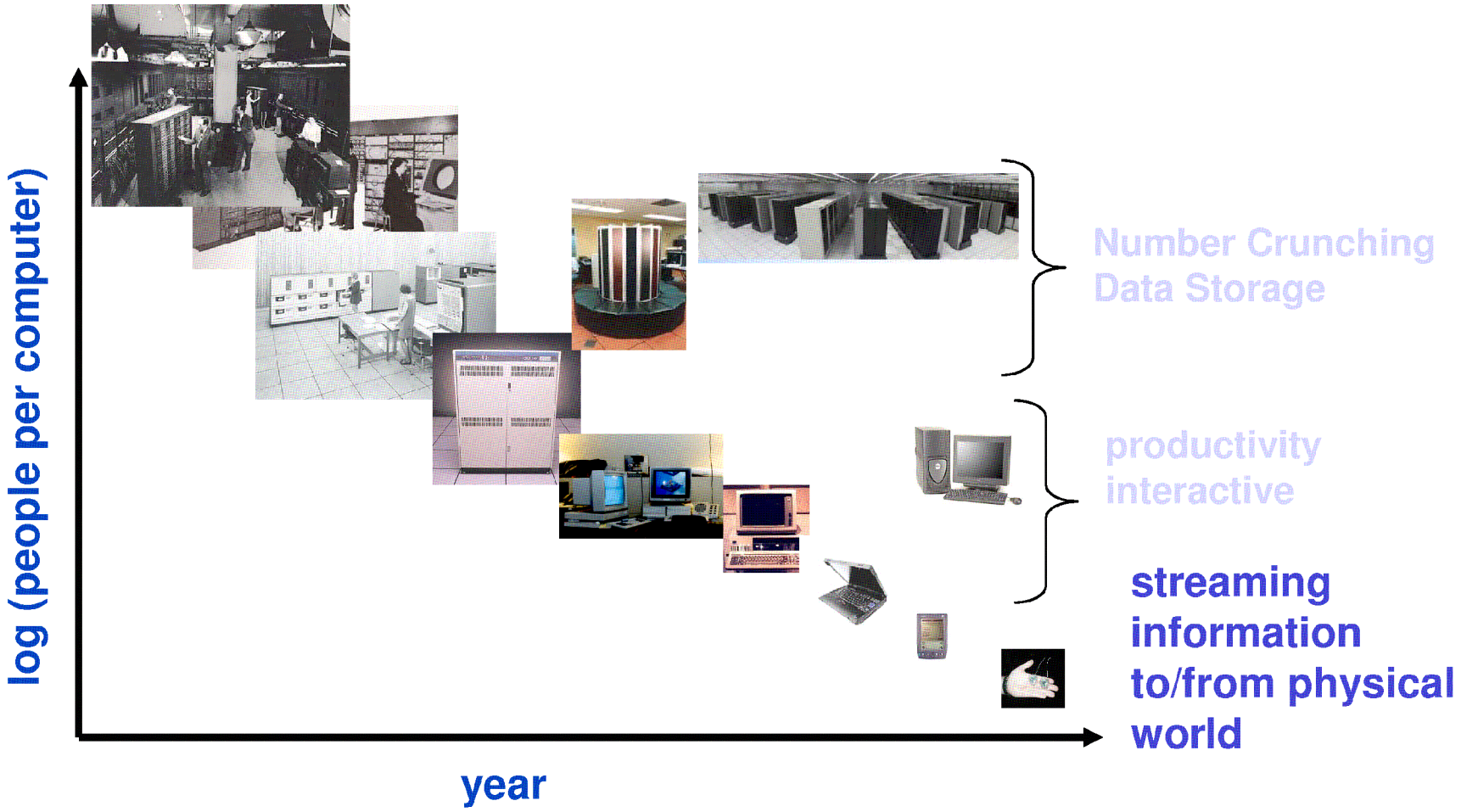


Complex interaction of multiple components in multiple administrative domains

COMPUTING DEVICES EVERYWHERE



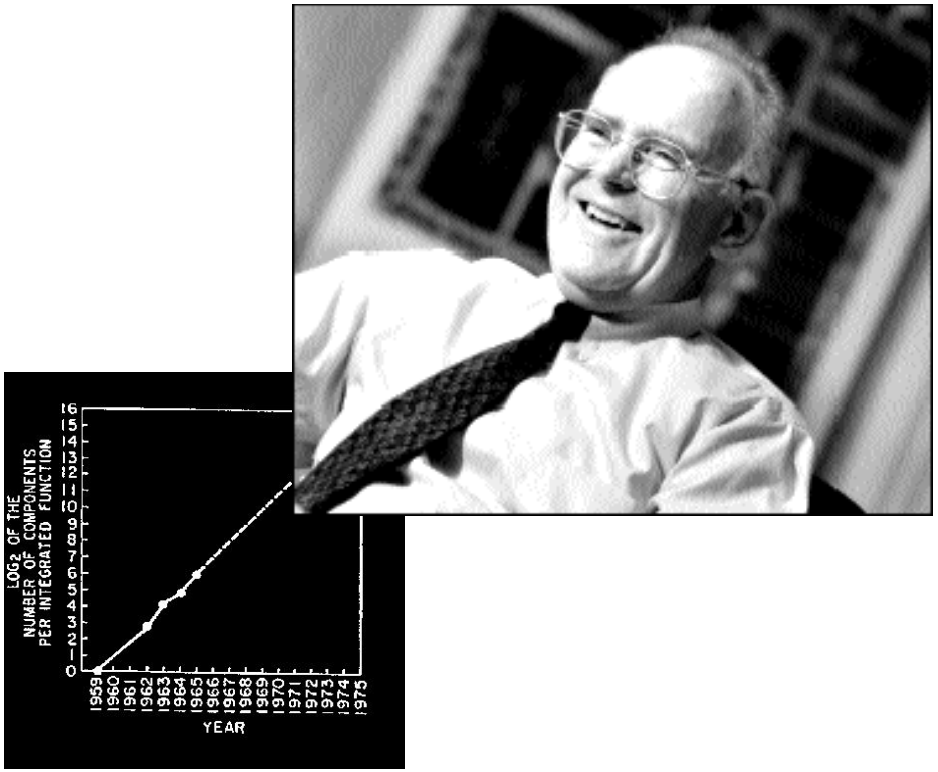
PEOPLE-TO-CPUS RATIO OVER



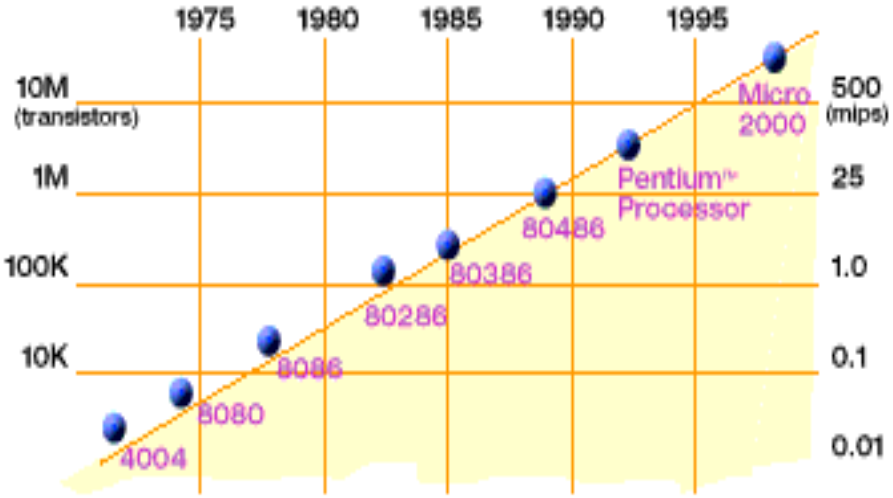
Today: Multiple CPUs/person!

- Approaching 100s?

TECHNOLOGY TRENDS: MOORE'S LAW



Gordon Moore (co-founder of Intel) predicted in 1965 that the transistor density of semiconductor chips would double roughly every 18 months.



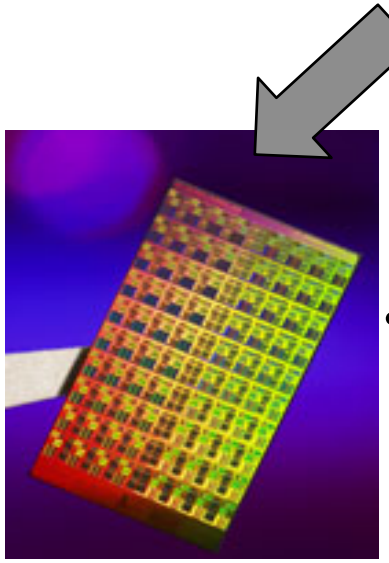
2X transistors/Chip Every 1.5 years

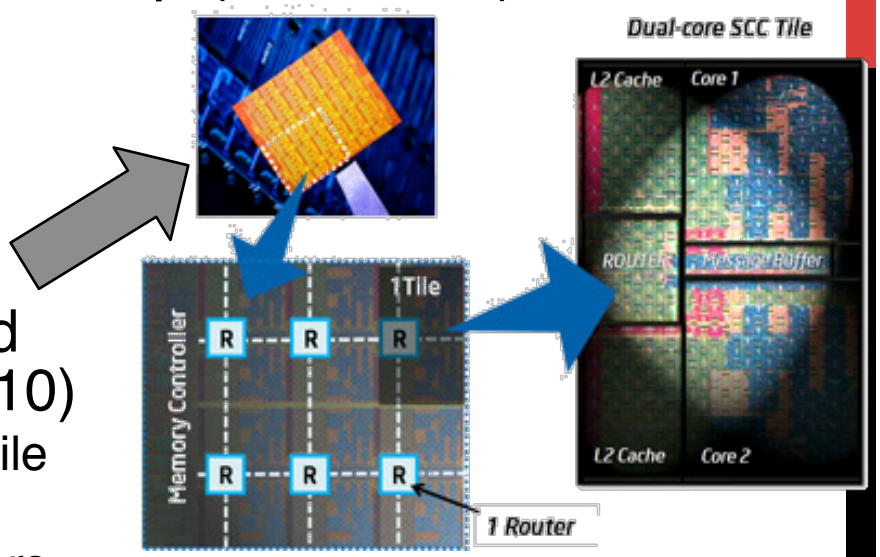
Called "Moore's Law"

Microprocessors have become smaller, denser, and more powerful.

MANYCORE CHIPS

- Intel 80-core multicore chip (Feb 2007)
  - 80 simple cores
  - Two FP-engines / core
  - Mesh-like network
  - 100 million transistors





- Intel Single-Chip Cloud Computer (August 2010)
  - 24 "tiles" with two cores/tile
  - 24-router mesh network
  - 4 DDR3 memory controllers
  - Hardware support for message-passing

"ManyCore" refers to many processors/chip

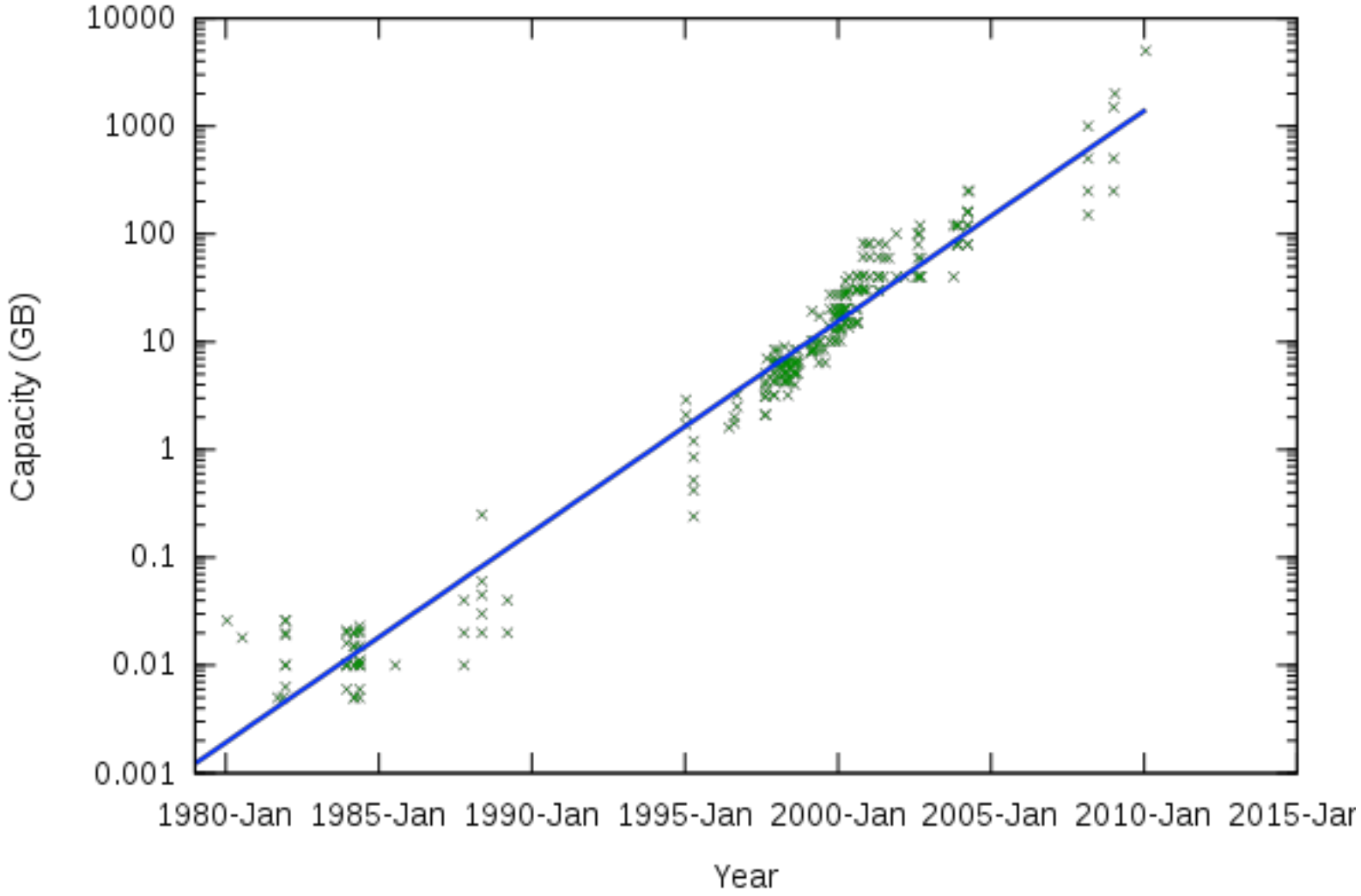
- 64? 128? Hard to say exact boundary

How to program these?

- Use 2 CPUs for video/audio
- Use 1 for word processor, 1 for browser
- 76 for virus checking???

Parallelism must be exploited at all levels

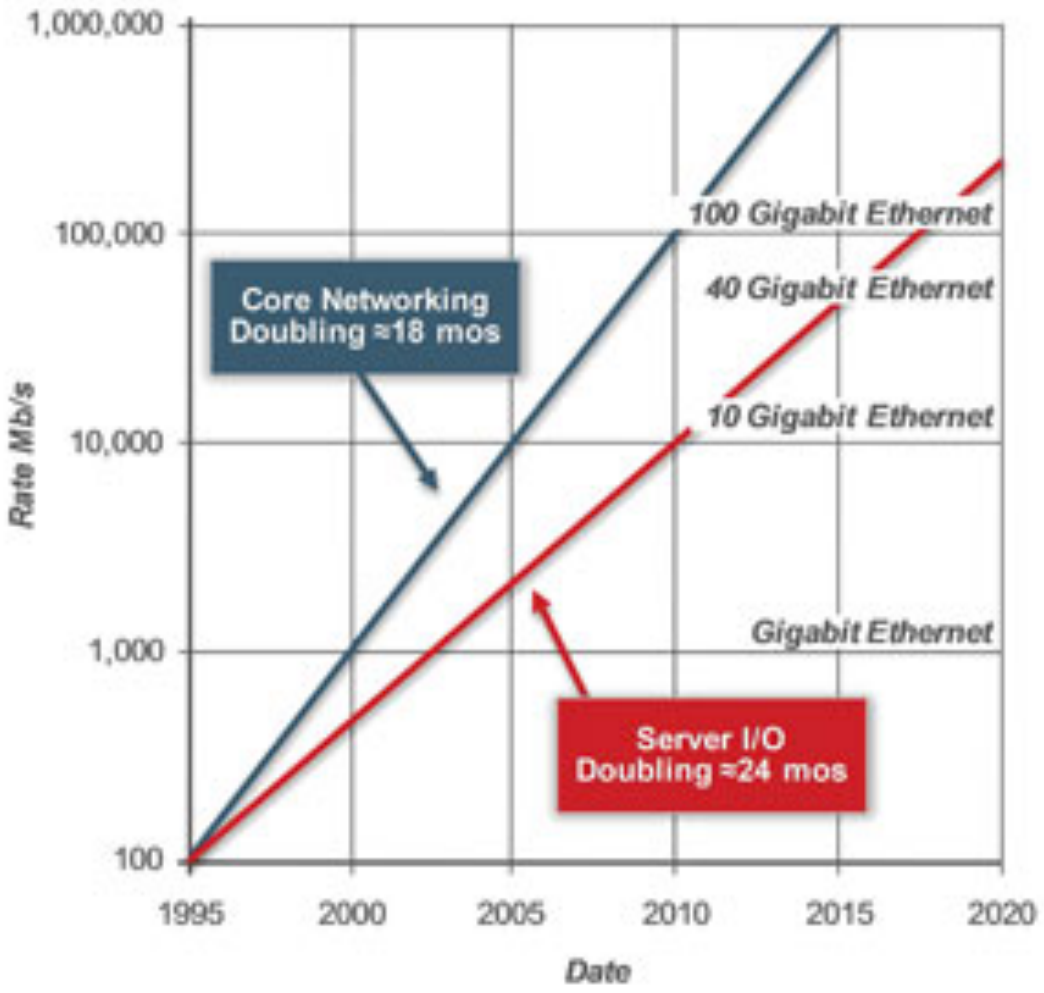
STORAGE CAPACITY



***Retail* hard disk capacity in GB**

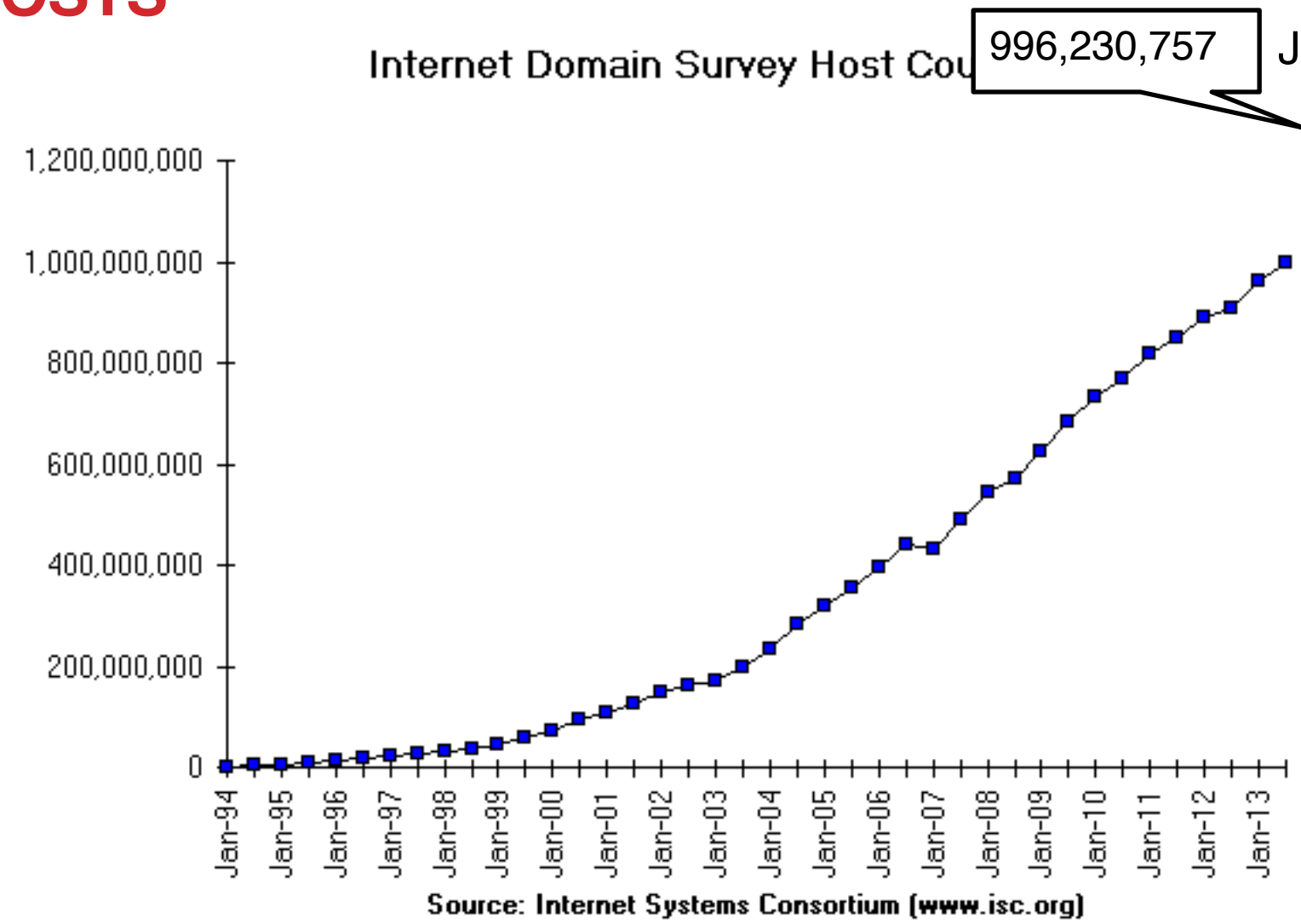
(source: http://www.digitaltonto.com/2011/our-emergent-digital-future/)

NETWORK CAPACITY



(source: http://www.ospmag.com/issue/article/Time-Is-Not-Always-On-Our-Side)

INTERNET SCALE: .96 BILLION HOSTS



https://www.isc.org/solutions/survey

INTERNET SCALE: ~2.5 BILLION USERS!

WORLD INTERNET USAGE AND POPULATION STATISTICS June 30, 2012						
World Regions	Population (2012 Est.)	Internet Users Dec. 31, 2000	Internet Users Latest Data	Penetration (% Population)	Growth 2000-2012	Users % of Table
Africa	1,073,380,925	4,514,400	**167,335,676**	15.6 %	3,606.7 %	7.0 %
Asia	3,922,066,987	114,304,000	**1,076,681,059**	27.5 %	841.9 %	44.8 %
Europe	820,918,446	105,096,093	**518,512,109**	63.2 %	393.4 %	21.5 %
Middle East	223,608,203	3,284,800	**90,000,455**	40.2 %	2,639.9 %	3.7 %
North America	348,280,154	108,096,800	**273,785,413**	78.6 %	153.3 %	11.4 %
Latin America / Caribbean	593,688,638	18,068,919	**254,915,745**	42.9 %	1,310.8 %	10.6 %
Oceania / Australia	35,903,569	7,620,480	**24,287,919**	67.6 %	218.7 %	1.0 %
WORLD TOTAL	**7,017,846,922**	**360,985,492**	**2,405,518,376**	**34.3 %**	**566.4 %**	**100.0 %**

NOTES: (1) Internet Usage and World Population Statistics are for June 30, 2012. (2) CLICK on each world region name for detailed regional usage information. (3) Demographic (Population) numbers are based on data from the US Census Bureau and local census agencies. (4) Internet usage information comes from data published by Nielsen Online, by the International Telecommunications Union, by GfK, local ICT Regulators and other reliable sources. (5) For definitions, disclaimers, navigation help and methodology, please refer to the Site Surfing Guide. (6) Information in this site may be cited, giving the due credit to www.internetworldstats.com.

(source: http://www.internetworldstats.com/stats.htm)

NOT ONLY PCS CONNECTED TO THE INTERNET

Smartphone shipments now exceed PC shipments!

2011 shipments:

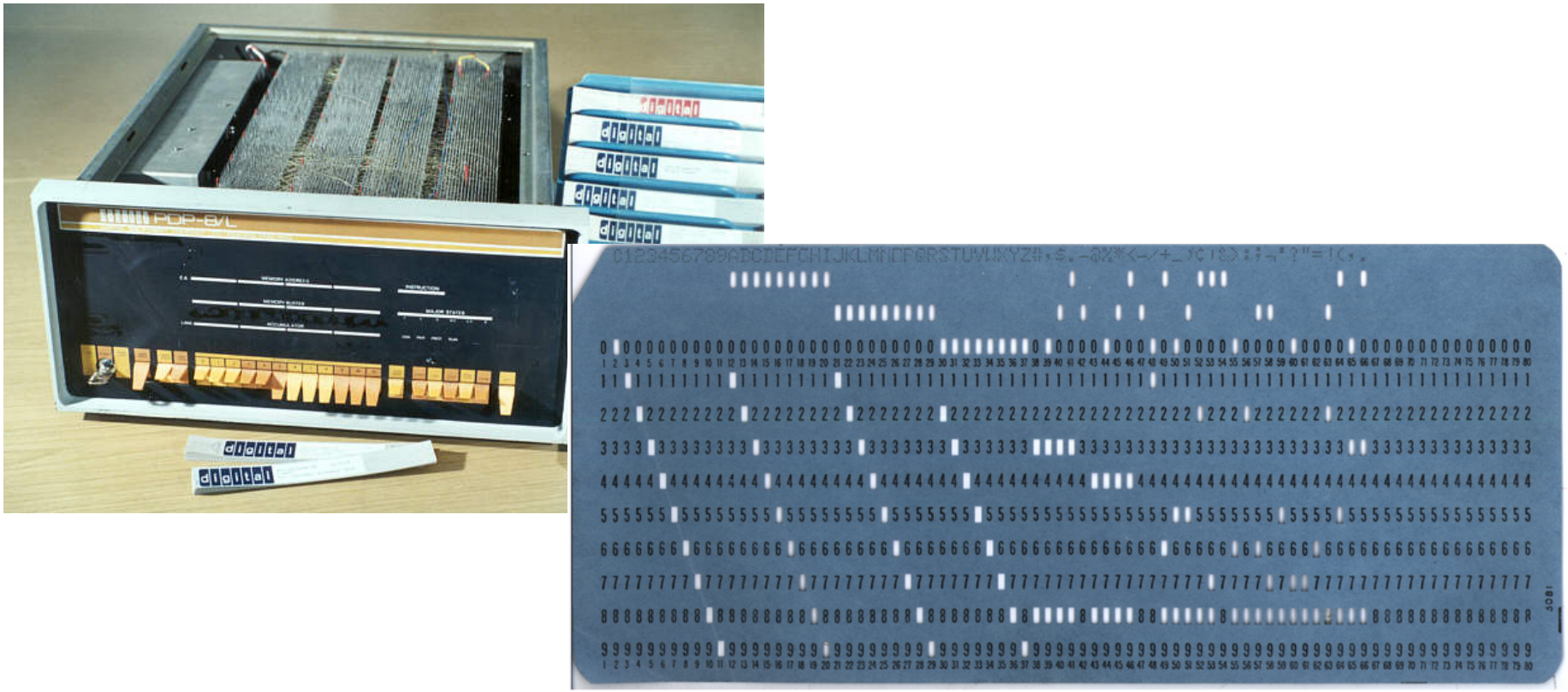
- 487M smartphones
- 414M PC clients
  - 210M notebooks
  - 112M desktops
  - 63M tablets
- 25M smart TVs

4 billion phones in the world → smartphone over next decade

QUESTION

How to manage such complexity?

- **Abstractions!**



THE INSTRUCTOR

Rong Zheng

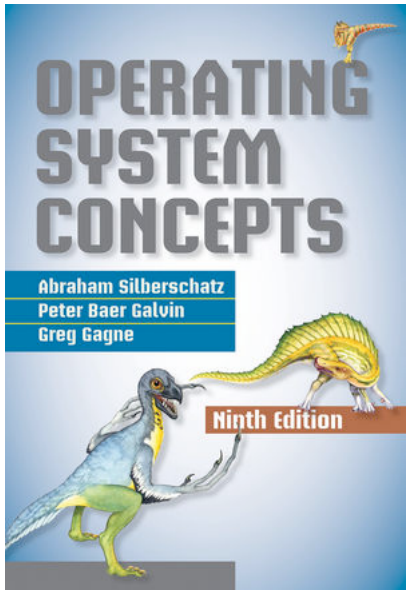
- **Office: ITB 121**
- **Office hr: Wed. 3:30 – 5:30pm**
- **Course homepage: http://www.cas.mcmaster.ca/~rzheng/course/CAS4J03w14/**
- **Research areas:**
  - Mobile & pervasive computing
  - Wireless networking

THE TAS

- **Ala Shaabana (shaabaa@mcmaster.ca)**
  - Thu 1 -3pm, ITB 116
- **Zhaowei Tian (felix.z.tian@gmail.com)**
  - Thu 9 – 11am, ITB 207
- **Qiang Xu (xuq22@mcmaster.ca)**
  - Fri 3 – 5pm, ITB 116

TEXTBOOK

A. Silberschatz, P. Gavin and G. Gagne, *Operating Systems Concepts*, 9th edition, Wiley & Sons



ORGANIZATION OF THE COURSE

Scope

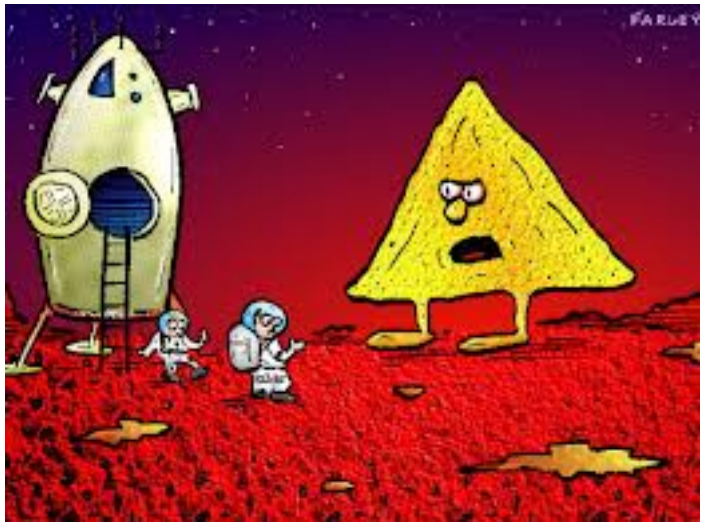
- **Process management**
- **Synchronization**
- **Memory management**
- **File system & I/O**
- **Networking**
- **Advanced topics**

3 programming assignments (45%), midterm (20%), final (25%), pop quiz (10%)

PROGRAMMING ASSIGNMENTS

Nachos (Not Another Complete Heuristic Operating System) 5.0j

- **An instructional OS ported to Java**
- **To understand abstract "concepts" introduced in the lectures**
- **To implement key building blocks of OS**



PROGRAMMING ASSIGNMENTS

- Done in groups
- Two phases: design documents and code submission
- Autograder codes will be provided for testing
- In some projects, you may need to develop your own test cases/codes
- More details will be provided by the TAs during lab session

THE HARE AND THE TURTLE

BEHAVING IN THE CLASSROOM

Non course-related activities such as answering their phones, browsing the web or playing solitaire are discouraged