Distributed Computer Systems Engineering

CIS 508: Lecture 1
Overview

Lecturer: Sid C.K. Chau
Email: ckchau@masdar.ac.ae

Masdar INSTITUTE CIS

What is this course about

In a nutshell, anything about "More Than One Computer System"

- Systems in ***different*** locations
- Systems in ***different*** logical places
- Systems performing ***different*** functions, tasks, operations
- Systems owned by ***different*** organizations
- Systems in ***different*** designs, protocols, standards
- Systems are .. ***different***!

What is this course about

In a nutshell, anything about
"More Than One Computer System"

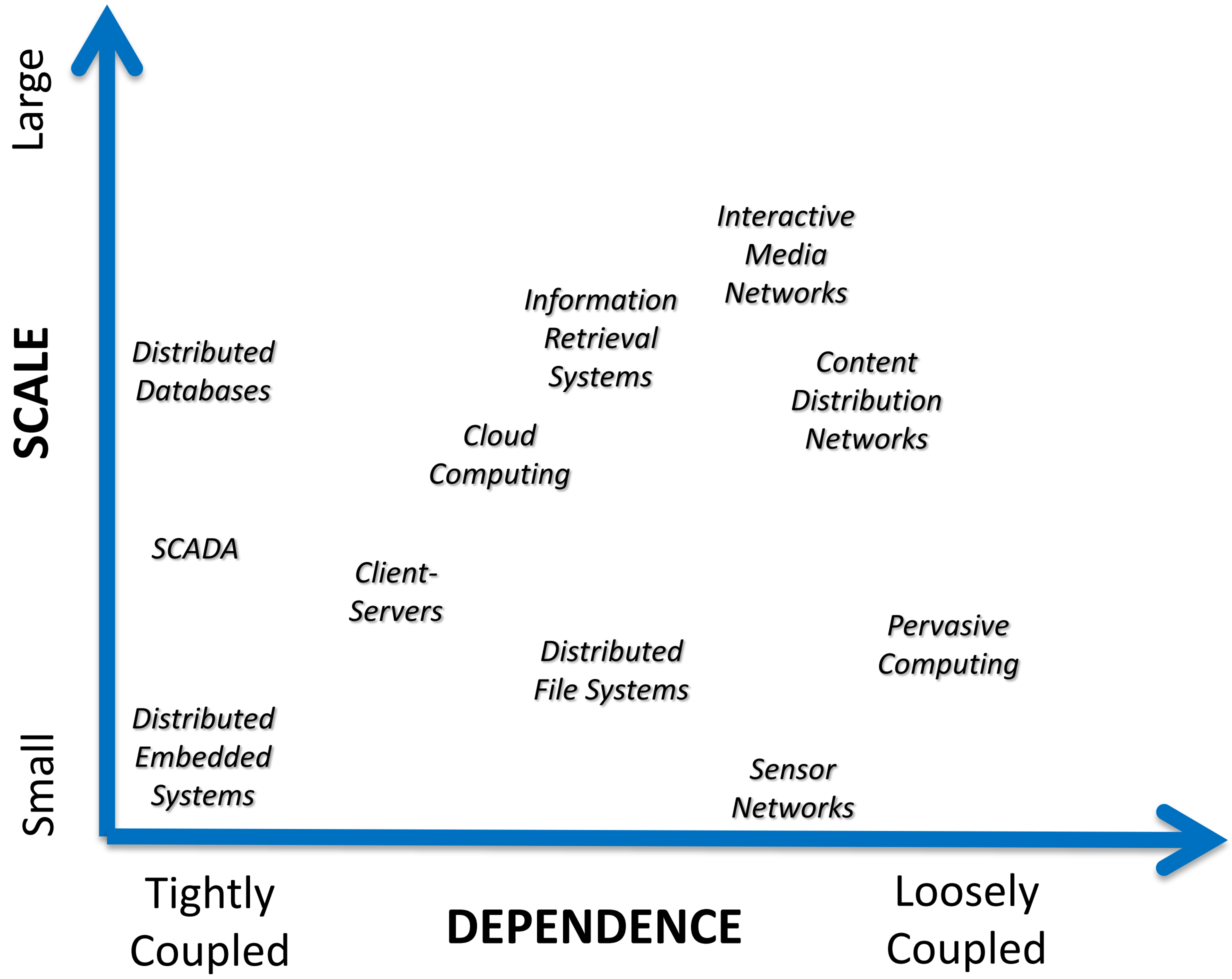
- How to enable different systems to work together?
  - One system provides the ***inputs*** to other systems
  - One system depends on the ***outputs*** from other systems
- How to share ***data*** among systems?
- How to ensure ***robustness, security, efficiency***?
- Many practically important and theoretically intriguing questions

What is this course about

Examples:

- *Distributed database systems*
  - Handle transactions among banks (traditional distributed systems)
- *Distributed embedded systems*
  - Connect controllers/microprocessors in cars/planes/plants
  - Tightly coupled interaction of systems
- *Mobile devices, sensors, appliances*
  - Internet-of-things, Pervasive computing
  - Loosely coupled interaction of systems

Many, Many Examples



Benefits

- **Economy**
  - Multiple low-end systems are cheaper than a single high-end centralized system
- **Efficiency**
  - Multiplexing multiple lowly utilized systems
  - Merging the workload of lowly utilization systems
- **Geographical Separation**
  - Resources can span multiple organizations, domains, countries
  - Data can locate in different locations, users access from different locations
- **Flexibility**
  - Pooling resources to support different applications simultaneously
- **Reliability**
  - Aggregating multiple unreliable systems
- **Scalability**
  - Allowing dynamic incremental upgrade

Challenges

- **Interoperability**
  - Standardized interfaces and abstractions between different computer systems
- **Consistency**
  - Data sharing among simultaneous systems without errors, deadlocks, uncertainty
- **Fault Tolerance**
  - Systems availability despite failures, crashes, unexpected events
- **Asynchrony**
  - Tolerate communication latency, inaccurate clock, scheduled operation shut-down
- **Dynamics**
  - Tolerate fluctuations in resources, network connectivity, uncertain participants
- **Networking**
  - Sufficient network connectivity to enable communications
- **Security**
  - Open to unintended accesses, malicious attackers

The *Evolving* Industry

First Generation: Enterprises & Infrastructure

Second Generation: Information & Contents

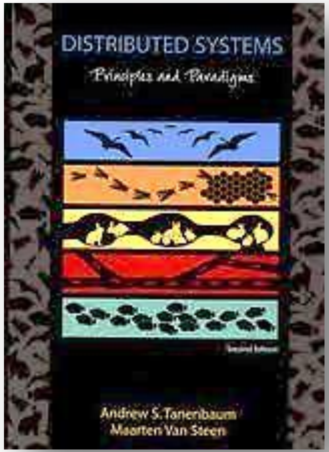
Third Generation: Social, Pervasive & Interactive Media

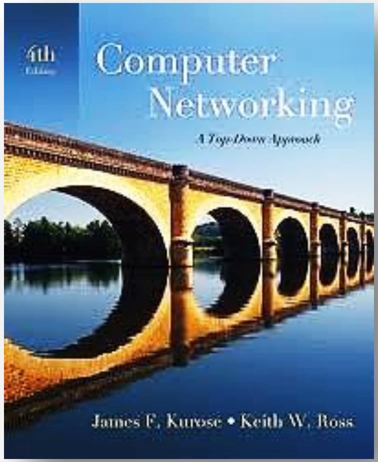
<<This is You ?>>

Fourth Generation & Beyond: Internet-of-things, Autonomous Cars/Robots

Books and Readings

- Textbooks (partially covered in this course)
  - Distributed Systems: Principles and Paradigms
    Andrew Tanenbaum and Maarten van Steen; Prentice Hall
  - Computer Networking
    James F. Kurose and Keith W. Ross; Pearson Addison-Wesley





- Plus other supplementary readings (e.g. papers, websites)

How is this course taught

- *13 Lectures*
  - Teaching concepts and principles
- *4x3 Labs*
  - Hands-on experiences of systems
- *4 Assignments*
  - Open questions
  - Programming assignments of labs
- *Teaching Assistant*
  - Muhammad Aftab (maftab@masdar.ac.ae)
  - Majid Khonji (mkhonji@masdar.ac.ae)

Assessment

Assignments/Labs	**30%**
Mid-term Exam	**20%**
Final Exam	**20%**
Project	**30%**

About Labs

- *Android*
  - Basic programming of smart phones and developing Apps
- *AWS*
  - Basic operations for cloud computing; installing web applications
- *Arduino & Raspberry Pi*
  - Basic embedded system programming
  - Interconnecting sensors and gadgets

About Project

- *Purposes*
  - Leverage skills from labs to develop a creative project
  - To showcase innovative applications using mobile systems, cloud computing and embedded systems
- *Group Size*
  - 2 students
- *Tasks*
  - In-class demo (including public try-out)
  - Project report
- *Assessment*
  - 50%: Panel (including me, TA, other faculty)
  - 50 %: Peer review (by students themselves)

About Project

- *Rules*
  - Students are required to attend other students' presentations, and try out their applications
  - Then fill up a reviewer's form to assess other students' project and provide justifications and comments for improvements
  - Submit reviewer's form to me
  - Anonymous assessments and comments will be provided to the developers

About Project

- *Suggested Projects*
  - Social games (e.g. treasure hunting)
  - Crowd sourcing
  - Social instant messaging
  - Mobility sensing and tracking
  - Automotive apps (e.g. car-sharing)
  - Smart home apps
  - Healthcare apps
  - Internet-of-things apps
  - Entertainment (e.g. interconnecting with Kinect)

About Project

- *Assessment Criteria*
  - *Does the project demonstrate sufficient technicality?*
    - Demonstrating the use of Android (as front-end) and AWS (as back-end)
    - Arduino & Raspberry Pi are optional, but are encouraged
  - *Is the project creative?*
    - Demonstrating creativity in application designs, concepts, and use of technologies
    - Graphical interface is **not** emphasized
  - *Has the project any potential to start a new business?*
    - Demonstrating novelty of ideas, or even potential for start-ups

About Project

- **Deadlines**
  - Finalizing group members: **early Feb**
  - Project demos: **early May**
  - Project report due: **early May**
- **Report**
  - Web-based reports
  - The report should document technical aspects of the project, challenges encountered, and future extensions
  - Multi-media contents should be submitted along with the report (e.g. UI figures and a demonstrating video in Youtube)

Tentative Course Plan

1	6 Jan	Lecture 1: Overview	
2	9 Jan	Lecture 2: Architecture	
3	13 Jan	Lecture 3: Consistency	
4	16 Jan	Lecture 4: Fault Tolerance	
5	27 Jan	Lecture 5: Wireless & Mobile Networks	
6	30 Jan	*Lab 1.1: (Android)*	Assignment 1 Due
7	3 Feb	*Lab 1.2: (Android)*	Lab Exercise 1.1 Due
8	6 Feb	*Lab 1.3: (Android)*	Lab Exercise 1.2 Due
9	10 Feb	Lecture 6: Cloud Computing	Lab Exercise 1.3 Due
10	13 Feb	*Lab 2.1: (AWS)*	
11	17 Feb	*Lab 2.2: (AWS)*	Lab Exercise 2.1 Due
12	20 Feb	*Lab 2.3: (AWS)*	Lab Exercise 2.2 Due
13	3 Mar	Lecture 7: Embedded Systems	Lab Exercise 2.3 Due
14	6 Mar	*Lab 3.1: (Arduino)*	Assignment 2 Due
15	10 Mar	*Lab 3.2: (Arduino)*	Lab Exercise 3.1 Due
16	13 Mar	*Lab 3.3: (Arduino)*	Lab Exercise 3.2 Due

Tentative Course Plan

17	17 Mar	**Mid-term**	Lab Exercise 3.3 Due
18	20 Mar	Lecture 8: Sensor Networks	
19	24 Mar	Lecture 9: Networking Protocols I	
20	27 Mar	Lecture 10: Networking Protocols II	
	31 Mar	Spring Break	
	3 Apr	Spring Break	
	7 Apr	Spring Break	
	9 Apr	Spring Break	
21	14 Apr	*Lab 4.1: (Raspberry Pi)*	Assignment 3 Due
22	17 Apr	*Lab 4.2: (Raspberry Pi)*	Lab Exercise 4.1 Due
23	21 Apr	*Lab 4.3: (Raspberry Pi)*	Lab Exercise 4.2 Due
24	24 Apr	Lecture 11: Peer-to-peer Systems	Lab Exercise 4.3 Due
25	28 Apr	Lecture 12: Distributed Algorithms: Byzantine Problem	
26	1 May	Lecture 13: Computing for Sustainability	
27	5 May	**Project Presentations**	Assignment 4 Due
28	8 May	**Project Presentations**	Project Report Due

Other Information

- **Course website:** http://cis508.SustainableNetworks.org
  - Course announcements
  - Lecture slides
  - Assignments
  - Project information
  - Lab instructions