CS 432
Distributed Systems and Net-Centric Computing

2nd term (2014-2015) 1435 H
Alexandria University
Faculty of Engineering
Computer and Systems Engineering Department

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Course Information

- **Instructors**
  Prof. Dr. Hussien Aly, alyh@computer.org
  Dr. Iman Elghandour, ielghand@alexu.edu.eg
- **Teaching Assistants**
  Eng. HebatoAllah Aly, heba.aly2011@gmail.com
- **Lectures:**
  Sunday 10:10 – 11:40 AM, Tuesday 10:10 – 11:40 AM
- **Tutorial:** Tuesday 8:30 – 10:00 AM
- **Labs:** Check with the TA for the course groups and times.

Course Objectives

- The main objective of this course is to study the fundamentals of distributed computing. The primary emphasis will be on the layers on top of the network layer and architectural views.
- Other Objectives:
  - Introduce protocols and algorithms used to manage distributed systems.
  - Address different issues that are related to distributed systems.
  - Give an overview of cloud computing and how the technology is evolving.
  - Gain hands on experience with Web technologies.

Resources

- Course notes:
  - Instructor lecture notes.
- Course web page:
  https://piazza.com/alexu.edu.eg/spring2015/cse432/home
  Signup page: https://piazza.com/alexu.edu.eg/spring2015/cse432
  Assignments and other needed materials.
  - Submitting your assignments and projects.
  - News and announcements related to the course.
  - Discussions. Instructors and TAs will monitor these discussions and answer when needed.
- Textbooks:
  - Couloris, G, Dollimore, J. and Kinberg, T; *Distributed Systems - Concepts and Design*, Fourth Edition, Addison-Wesley, Pearson Education, UK 2005.
  - Andrew S. Tanenbaum, Maarten Van Steen; *Distributed Systems: principles and Paradigms*, Second Edition, Prentice-Hall 2006.
  - Gerard Tel; Introduction to Distributed Algorithms, Cambridge University Press, 2nd ed, 2001.
  - Many individual web pages will be referenced as appropriate.

Evaluation

- Grading:
  - Total: 150
  - Final: 90
  - Class, Midterm: 30
  - Projects and labs: 30
- Absence:
  - We reserve the right to deduct Marks (up to 10% from the Term Work (60)) according to your absence pattern.
  - You may be forced *not to enter final exam* if absent more than 5 lectures.
- Cheating / Plagiarizing
  - Malpractices will be strictly penalized.
  - Includes using someone else's code or text in your deliverables.
  - It also includes sharing your code or text with others (Yes, you will also be penalized).
  - Discussing the assignments and projects (verbally) with your classmates is OK.

Course Contents

- **Introduction to Distributed Systems and Net-Centric Computing.**
  - Definition, Characteristics, and Challenges of Distributed Systems.
- **Distributed System Architectures and Models.**
  - Client-Sever, Peer-to-peer , Service Oriented Architecture.
- **Fundamental Models**
  - Interaction model, Failure model, Security model
- **Middleware technologies**
  - TCP/IP Sockets
  - RPC / RMI / CORBA / Web Services
  - Message-oriented Middleware
- **Naming Services.**
- **Synchronization in Distributed Systems.**

Course Contents (cont'd)

- **Distributed File Systems.**
  - E.g.: NFS, AFS, and GFS.
- **Replications, Consistency.**
  - Availability, Scalability.
  - Consensus Algorithm: Paxos.
  - Locking service: Chubby.
- **Fault Tolerance.**
- **Web Service Technologies.**
  - XML-based protocols.
  - SOAP.
  - WSDL.
  - UDDI.
- **Cloud Computing.**
- **Security issues of Distributed Systems.**

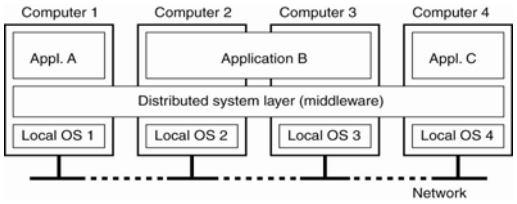
Introduction to Distributed Systems and Net-Centric Computing.

What is a Distributed System?

- Distributed computing deals with H/W & S/W systems containing more than one processing element, concurrent processes, or multiple programs, running under a loosely or tightly controlled regime. *[wikipidia]*
- "An interconnected collection of autonomous computers, processes, or processors" *[Gerard Tel]*
- "A system in which H/W or S/W components located at networked computers communicate and coordinate their actions only by message passing." *[Coulouris]*
- "A distributed system is a collection of independent computers that appear to the users of the system as a single computer." *[Tanenbaum]*
- Leslie Lamport gave a special definition --- discuss!
  - "*You know you have a DS when a crash of a computer you have never heard of stops you from getting any work done.*"

Middleware

- A software layer between the application and the operating system. This layer supports heterogeneous computers and networks while providing a single system view.
- Distributed applications consist of a set of processes that are distributed across a network of machines and work together as an ensemble to solve a common problem.
  - In the past, mostly "client-server" but now "Peer to Peer" computing represents a movement towards more "truly" distributed applications



Goals of Distributed Systems (1)

- For a distributed system to be *worth* the building efforts, the following important goals must be met:

1- Connecting users and resources:

- Economic reasons.
- Collaboration & exchange info.
- Security & privacy problems.

Goals of Distributed Systems (2)

2- Transparency:

- Hide the fact that its processes and resources are physically distributed across multiple computers.

Transparency	Description
Access	Hide differences in data representation and how a resource is accessed
Location	Hide where a resource is located
Migration	Hide that a resource may move to another location
Relocation	Hide that a resource may be moved to another location while in use
Replication	Hide that a resource may be replicated at several locations
Concurrency	Hide that a resource may be shared by several competitive users
Failure	Hide the failure and recovery of a resource
Persistence	Hide whether a (software) resource is in memory or on disk

- Degree of transparency vs. performance

Goals of Distributed Systems (3)

3- Openness

- It offers services according to standard rules that describe the syntax and semantics of those services. (IDL)
- Interoperability:
  - The extent by which two implementations of systems can co-exist and work together by merely relying on each other's services as specified by the standard.
- Portability:
  - The extent of an application developed for a DS "A" can be executed, without modification, on a different DS "B" that implement the same interface.

Goals of Distributed Systems (4)

4. Scalability
   - Scalable with respect to size
     - Easy add more users and resources without significant performance degradation.
   - Scalable with respect to geographical span
     - Performance is not much sensitive to users and resources being far apart.
   - Scalable with respect to administration
     - Still easy to mange even if it spans many independent administrative organization.

Characteristics of Distributed Systems

Computers in DS may be on separate continents, in the same building, or the same room. However they share the following:

- Heterogeneity
  - Usually different platforms
- Independent Failures
  - Each computer can fail independently of the others and independent from the communication channel.
- Parallel activities
  - Autonomous components executing concurrent tasks
- Communication via message passing
  - No shared memory
- Resource sharing
  - Printer, database, other services
- No global state
  - No single process can have knowledge of the current global state of the system
- No global clock
  - Only limited precision for processes to synchronize their clocks

Exercise #1 Ref: Coulouris Book

1. Give five types of hardware resource and five types of data or software resource that can usefully be shared. Give examples of their sharing as it occurs in practice in distributed systems.
2. A user arrives at a railway station that he has never visited before, carrying a PDA that is capable of wireless networking. Suggest how the user could be provided with information about the local services and amenities at that station, without entering the station's name or attributes. What technical challenges must be overcome?

Due date: See Course Piazza page
Submit it to course page proper link.