Introduction to the Course

Distributed Systems
Sistemi Distribuiti

Andrea Omicini
andrea.omicini@unibo.it

Dipartimento di Informatica – Scienza e Ingegneria (DISI)
Alma Mater Studiorum – Università di Bologna a Cesena

Academic Year 2014/2015
1. Distributed Systems: Why?

2. Distributed Systems: The Course
   - Goal & Structure
   - What to Do
Outline

1. Distributed Systems: Why?

2. Distributed Systems: The Course
   - Goal & Structure
   - What to Do
Nowadays, computational systems...

- ... have become pervasive, since they are everywhere, and tend to affect every aspect of our everyday life and activity.
- ... are at the core of most (if not all) artificial systems, so that every principled discipline for modelling / engineering computational systems affects the modelling and engineering of almost every sort of artificial systems.
Pervasiveness of computations

- how many computational systems today in this room?
  - in our cars, at home, in the workplaces, in hospitals, in public places?
- we live immersed in a sort of *computational cloud*, where an incredible (and always increasing) number of computations are performed at every instant
  - distributed, *concurrent* computations
  - either controlled / triggered, or *autonomous* computations
Pervasiveness of interaction

- almost any computational system of today comes equipped with ICT technologies for interacting with other computational systems.
- computational devices *continuously interact*
  - with humans
  - with each others
  - with the physical *environment* and its *resources*
The physical nature of artificial systems... 

... adds complexity to computational components / systems
- in terms of physical *distribution*
- in terms of temporal *distribution*
- in terms of *unpredictability* of the scenarios
What is distributed?

- computational units
- communication channels
- data / information / knowledge
  - along with their representations
- sensors, actuators, ...
  - the boundaries between the systems and the surrounding environment are topologically sparse
On the Notion of Distribution II

Spatio-temporal unity of systems is lost
- there is no longer a notion of \textit{system time}, nor a system \textit{location}
- system components, at different level of abstraction, are only \textit{partially related}
  - temporally & topologically

A number of assumptions over systems no longer hold
- system \textit{events no longer} constitute a totally-ordered set
  - generally speaking, partial ordering is the only feature
- admissible \textit{interactions} among system components \textit{no longer} depend on compresence
  - in space / time
  - within the same physical / virtual topology
Building artificial systems... 

- nowadays means building *distributed systems*
- whose core is represented by *distributed computational systems*
- which are to be *modelled* and *engineered*
Modelling distributed systems... 
- ... involves new theoretical problems
- so, it requires new theoretical frameworks, models, abstractions, techniques

Engineering distributed systems... 
- ... involves new practical problems
- so, it requires new technologies, infrastructures, methods, methodologies
Outline

1 Distributed Systems: Why?

2 Distributed Systems: The Course
   - Goal & Structure
   - What to Do
Goals of the Course

Students of this course should

- Learn the **fundamental issues** of distributed systems
- Re-think some of the most widely used **technologies** in nowadays distributed systems
  - **object-based** as a general trend in moving legacy models & technologies toward distributed systems
  - **web-based** as the most relevant case of today widespread distributed, knowledge-intensive systems
- Take a look at some of the hottest **new trends**
- Experiment with **novel distributed technologies**
  - **coordination-based** and **agent-based** as general-purpose approaches to advanced technologies for intelligent & pervasive systems
Structure of the Course: Main Topics I

Generality on distributed systems
- Basic problems and definitions
- Software architectures
- Middleware & infrastructure

Issues of distributed systems
- Communication
- Naming
- Synchronisation
- Consistency & replication
- Fault tolerance
Main sorts of distributed systems

- Web-based systems (*generality*)
- From distributed object-based systems to agent-based systems
- Agent-based systems
- Coordination-based systems
- Cloud-based systems
Material of the Course: Main Book

[TvS07a]
*Distributed Systems. Principles and Paradigms*

[TvS07b]
*Sistemi Distribuiti*
Pearson Education Italia, Torino, Italia, 2ª edizione.

This book represents the main guide throughout the first part of the course—basics & issues.
Material of the Course: Other Books I

[CDKB12]
Coulouris, G., Dollimore, J., Kindberg, T. and Blair, G. (2012)
_Distributed Systems. Concepts and Design_
Pearson

[Bir05]
Birman, K.P. (2005)
_Reliable Distributed Systems. Technologies, Web Services, and Applications_
Springer
[KS11]

Kshemkalyani, A.D. and Singhal, M. (2011)
*Distributed Computing. Principles, Algorithms, and Systems*
Cambridge University Press
The last part of the course, on the main sorts of distributed systems,

- will contain some references to the Tanenbaum & van Steen book chapters
- but will mainly evolve according to a different perspective, as reported on the course’s slide.
Schedule

Classes

- Tuesday, h. 10-13, Room B, via Sacchi 3
- Thursday, h. 10-13, Room B, via Sacchi 3
Laboratory

Where, when, who

- Tuesday, h. 10–13, Lab 3, via Sacchi 3
- with Prof. Andrea Omicini & Ing. Stefano Mariani

http://apice.unibo.it/xwiki/bin/view/Courses/Sd1415Lab

- The Lab will be the place where the technologies for distributed systems are presented and experimented
- It will be organised on a week-per-week basis
- Please check
  http://apice.unibo.it/xwiki/bin/view/Courses/Sd1415Schedule
Attitude toward the Course

Attending lessons is important

- The topic is really general and rich of subtleties
- A lot of “implicit knowledge” is transferred orally

Material may be enough to pass the exam, anyway...

- ... for those who have problems attending lessons—like, worker students
- ... or, for those who just hate the Professor’s voice / face / slides / attitude / whatever
Registering to the Course

Professors-students lists... are provided for free by the Alma Mater Studiorum. They mostly work and we will use them here.

Please register soon... to the list andrea.omicini.SD-1415 using password 1415SD like, say, today.
References

Kenneth P. Birman.  
*Reliable Distributed Systems. Technologies, Web Services, and Applications.*  

George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair.  
*Distributed Systems. Concepts and Design.*  

Ajay D. Kshemkalyani and Mukesh Singhal.  

Andrew S. Tanenbaum and Marteen van Steen.  
*Distributed Systems. Principles and Paradigms.*  
Introduction to the Course

Distributed Systems
Sistemi Distribuiti

Andrea Omicini
andrea.omicini@unibo.it

Dipartimento di Informatica – Scienza e Ingegneria (DISI)
Alma Mater Studiorum – Università di Bologna a Cesena

Academic Year 2014/2015