

Introduction to the Course

Distributed Systems

Sistemi Distribuiti

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Academic Year 2015/2016

- 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



Pervasive Computation & Interaction I

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

Pervasive Computation & Interaction II

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

Pervasive Computation & Interaction III

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*

Physical vs. Computational

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

On the Notion of Distribution I

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 *system time*, nor a system *location*
- system components, at different level of abstraction, are only *partially related*
 - temporally & topologically

A number of assumptions over systems no longer hold

- system *events no longer* constitute a totally-ordered set
 - generally speaking, partial ordering is the only feature
- admissible *interactions* among system components *no longer* depend on compresence
 - in space / time
 - within the same physical / virtual topology

Building Artificial Systems Nowadays I

Building artificial systems. . .

- . . . nowadays means building *distributed systems*
- whose core is represented by *distributed computational systems*
- which are to be *modelled* and *engineered*

Building Artificial Systems Nowadays II

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

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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

Structure of the Course: Main Topics II

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]

Tanenbaum, A. S. and van Steen, M. (2007)

Distributed Systems. Principles and Paradigms

Pearson Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition.

[TvS07b]

Tanenbaum, A. S. and van Steen, M. (2007)

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Pearson Education Italia, Torino, Italia, 2^a 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

Material of the Course: Other Books II

[KS11]

Kshemkalyani, A.D. and Singhal, M. (2011)

Distributed Computing. Principles, Algorithms, and Systems

Cambridge University Press

Material of the Course: Slides

<http://apice.unibo.it/xwiki/bin/view/Courses/Sd1516Slides>

- slides will be available from the course web site
- along with any additional information—e.g., related literature

After the beginning of the course – on the main sorts of distributed systems – the remainder of the classes

- 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, Lab 3, via Sacchi 3
- Friday, h. 14-17, Room A, via Sacchi 3

<http://apice.unibo.it/xwiki/bin/view/Courses/Sd1516Schedule>

Any variation, extension, cancellation will be communicated via

- schedule page
- professor / students mailing list `andrea.omicini.SD-1516`

Organisation of the Course

Professors-students lists

- are provided for free by the ALMA MATER STUDIORUM
- mostly work
- used here

Please register *soon...*

- to the list `andrea.omicini.SD-1516`
- using password 1516SD
- like, say, *today*.

Laboratory

Where, when, who

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

<http://apice.unibo.it/xwiki/bin/view/Courses/Sd1516Lab>

- slides will be available from the lab web page
- along with any additional materials—e.g., links, code, exercises

Attitude toward the Course

Attending lessons is useful

- 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

Exams

Final exams

- mostly consist of an oral discussion about the main themes of the course
- can be asked at any time of the year, typically via email

Projects

- a project can constitute an alternative path w.r.t. oral exam
- it should cover a specific topic of the course
- it may concern theoretical / technological / methodological aspects
- it may be developed by individuals or groups
- it has to be negotiated with the Professor, in order to ensure
 - its focus on distributed systems, as well as
 - its feasibility in a reasonable amount of time

References



Kenneth P. Birman.

Reliable Distributed Systems. Technologies, Web Services, and Applications.

Springer New York, 2005.



George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair.

Distributed Systems. Concepts and Design.

Pearson, 5th edition, 2012.



Ajay D. Kshemkalyani and Mukesh Singhal.

Distributed Computing. Principles, Algorithms, and Systems.

Cambridge University Press, March 2011.



Andrew S. Tanenbaum and Marteen van Steen.

Distributed Systems. Principles and Paradigms.

Pearson Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2007.



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