

# Distributed systems: paradigms and models

Prof. Marco Danelutto  
Dept. Computer Science  
University of Pisa

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*Master Degree (Laurea Magistrale) in  
Computer Science and Networking  
Academic Year 2009-2010*





# Contents

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- **Introduction to course**
  - *General motivations*
  - *Course program*
  - *Support material*
  - *Lessons, exams, question time, ...*
- **Technical motivations**
  - *architecture*
  - *programming (models)*

# General motivations

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- **Huge improvement of parallel/distributed architectures**
  - *multi/many core*
  - *massively parallel/distributed architectures*
- **Distributed/parallel dichotomy**
  - *less and less differences in techniques and architectures*
  - *mainly related to grain of the involved entities*
  - *moving from coarse grain distributed architectures (distributed PEs) to fine grain distributed architectures (distributed on-chip cores)*

# General motivations (2)

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- **Advances in programming parallel/distributed systems**
  - *classical distributed system*
    - algorithms (time synchronization, election, mutual exclusion, ...), mechanisms (RPC), hardware (Fast Ethernet)
  - “*de facto*” standards for parallel programming
    - MPI (message passing), OpenMP (shared memory)
  - *software engineering concepts*
    - OO & component based programming models, design patterns/algorithmic skeletons

# Current status

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- **efficient programming of parallel/distributed systems**
  - *quite an “art”*
  - *requires deep knowledge of the target architecture features*
    - mechanisms to support program deployment, synchronization, communication, ...
    - data management (shared data, data/program files, licenses)
  - *reliability, debugging and tuning: serious concerns*
  - *mostly performed at a low abstraction level*
    - to achieve performance, efficiency, reliability

# Course main aim

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- **Provide overview of state-of-the-art paradigms and models**
  - *with the associated tools*
- **Provide a methodology**
  - *supporting parallel/distributed programming*
  - *on a variety of targets, with different grains, ranging from grids/clouds/COWs/NOWs to multi/many cores*
  - *making the best usage of existing technology*
  - *relieving the application programmer more and more from the target related concerns*



# Course program

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- **Introduction**
  - *motivations*
- **Part I: structured programming models**
  - *algorithmic skeletons / design patterns*
  - *evidencing methodological aspects (to be reused later)*
- **Part II: unstructured programming models**
  - *components, workflows, grid&cloud “middleware”*
  - *evidencing current usage praxis as well as potentialities*



# Course program (2)

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- **Part III: advanced networks**
  - *wireless networks in distributed systems*
  - *supporting multimedia*
  - *peer to peer solutions*
- **Part IV: technology**
  - *models, frameworks & tools*





# The methodology

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- **Design phase**
  - *high level*
  - *qualitatively investigating problems and relative solutions*
- **Implementation phase**
  - *relying on the “best” implementation technology*
  - *possibly designing ad hoc support tools*
- **Mostly inherited from algorithmic skeletons / design patterns**
  - *cost models, structuring information exploitation, etc.*

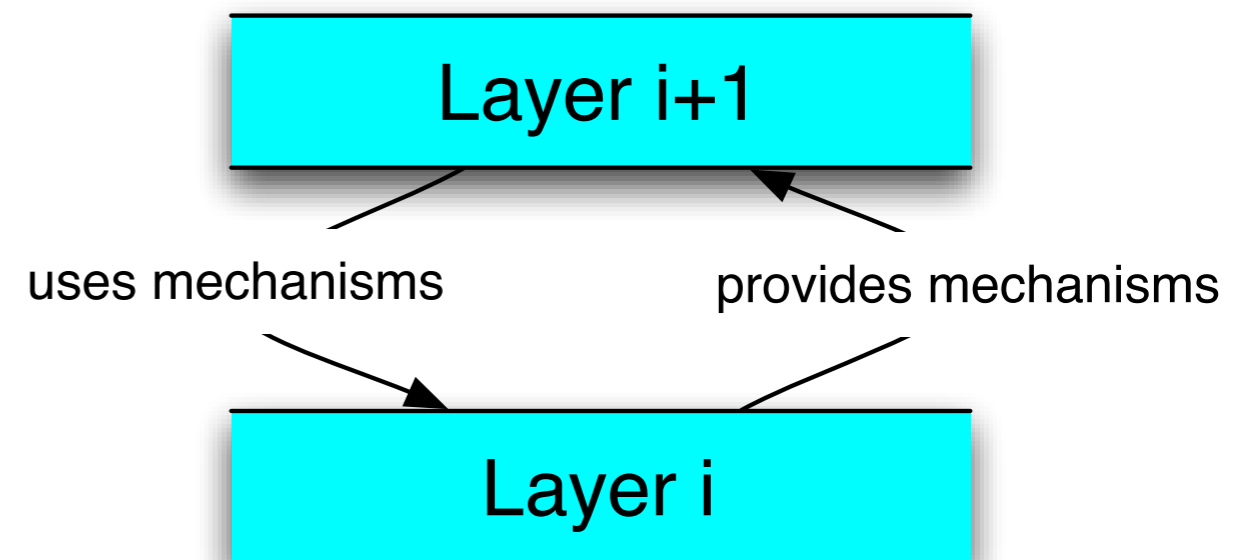
# Layered approach

- **Upper layers**

- *higher abstraction level*
  - policies, tools, ...
- *closer to programmer/user mind attitude*

- **Lower layers**

- *lower abstraction level*
  - mechanisms, libraries, ...
- *closer to target hardware*





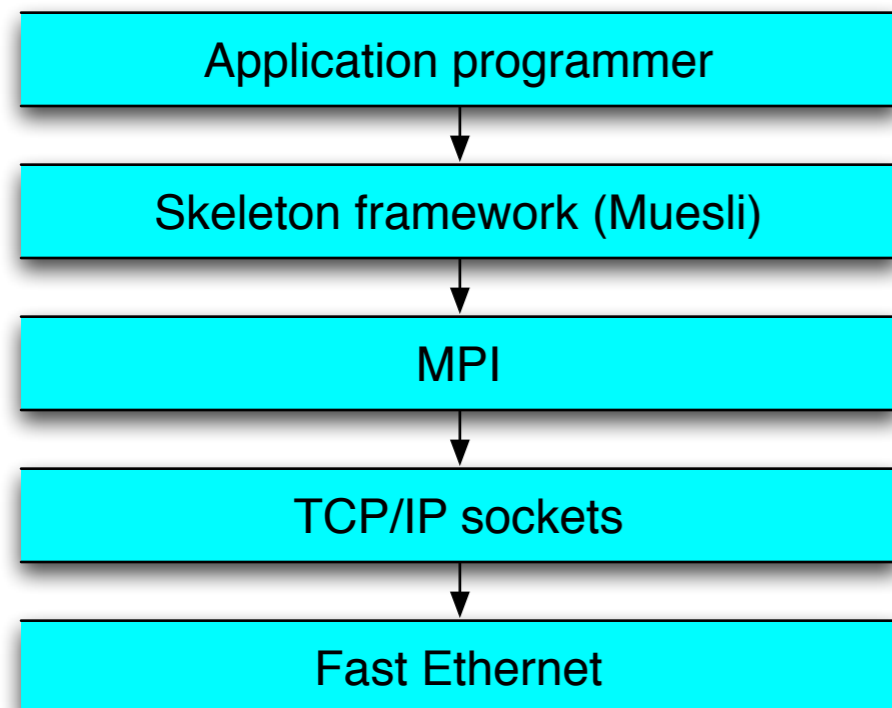
# Layered approach (2)

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- **For efficiency reasons**
  - *layer  $i+k$  may access layer  $i$  mechanisms directly*
- **Application programmer**
  - *should always use abstractions provided by topmost layer in the hierarchy*
    - efficiency reasons
    - security reasons

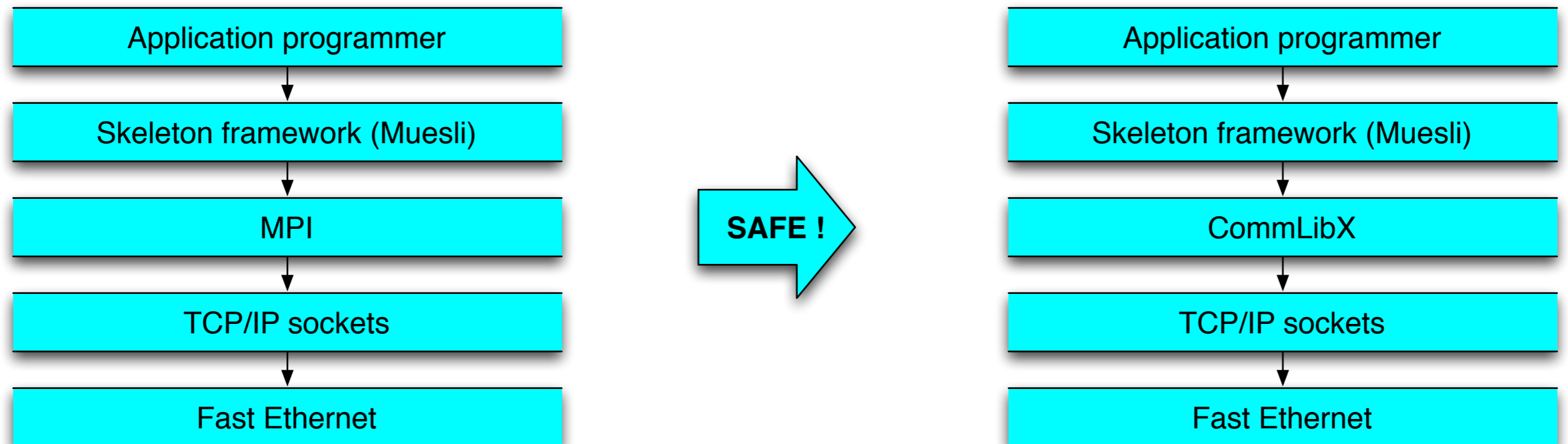
# Layered approach: sample case

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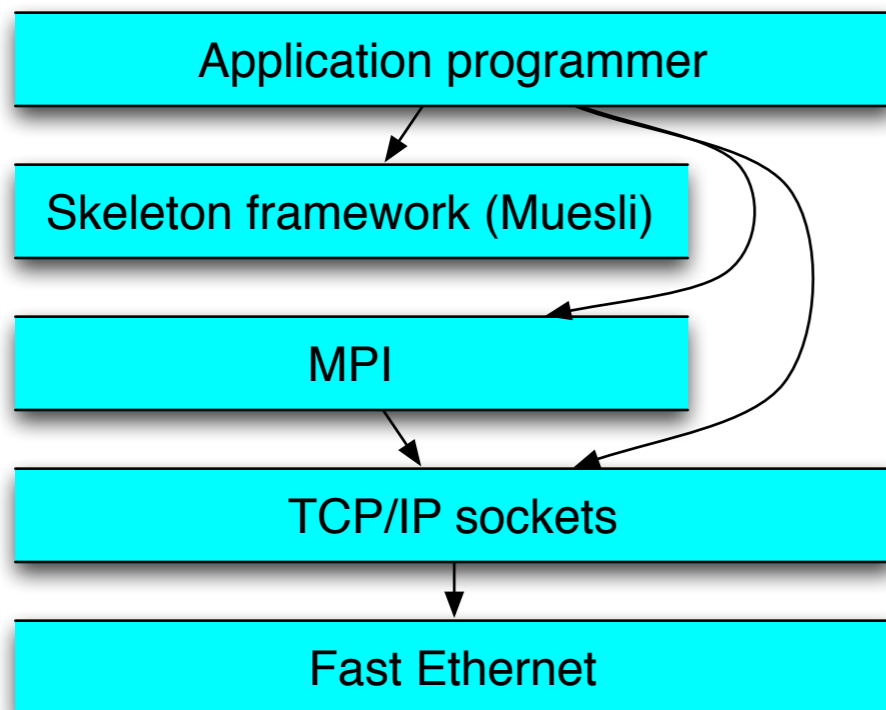
Proper layered design

# Layered approach: sample case



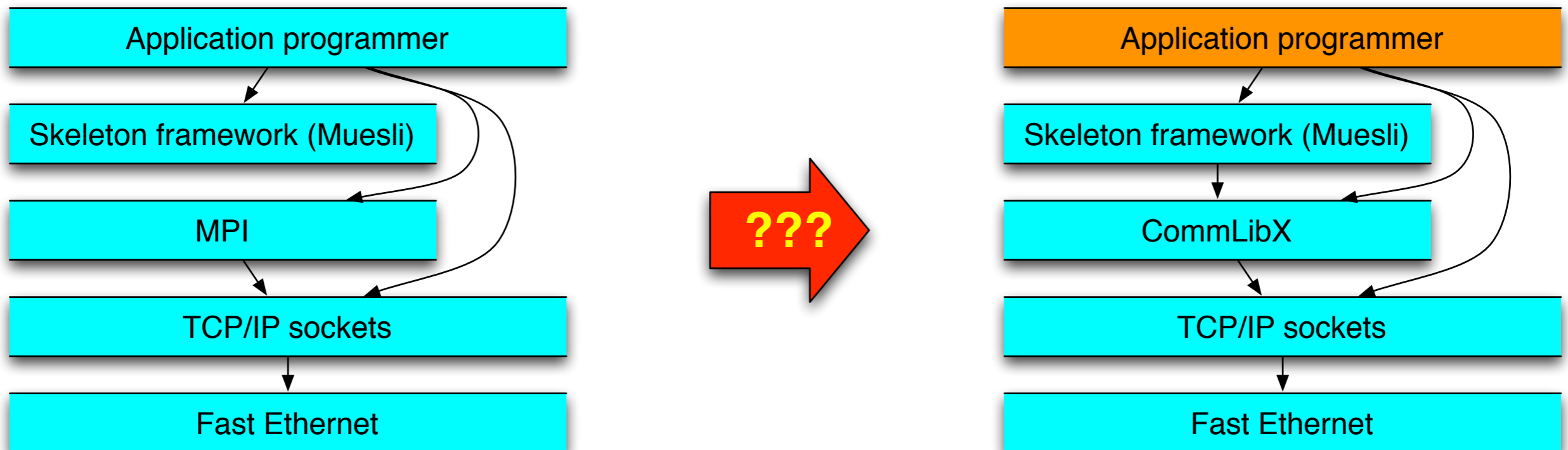
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# Layered approach: sample case



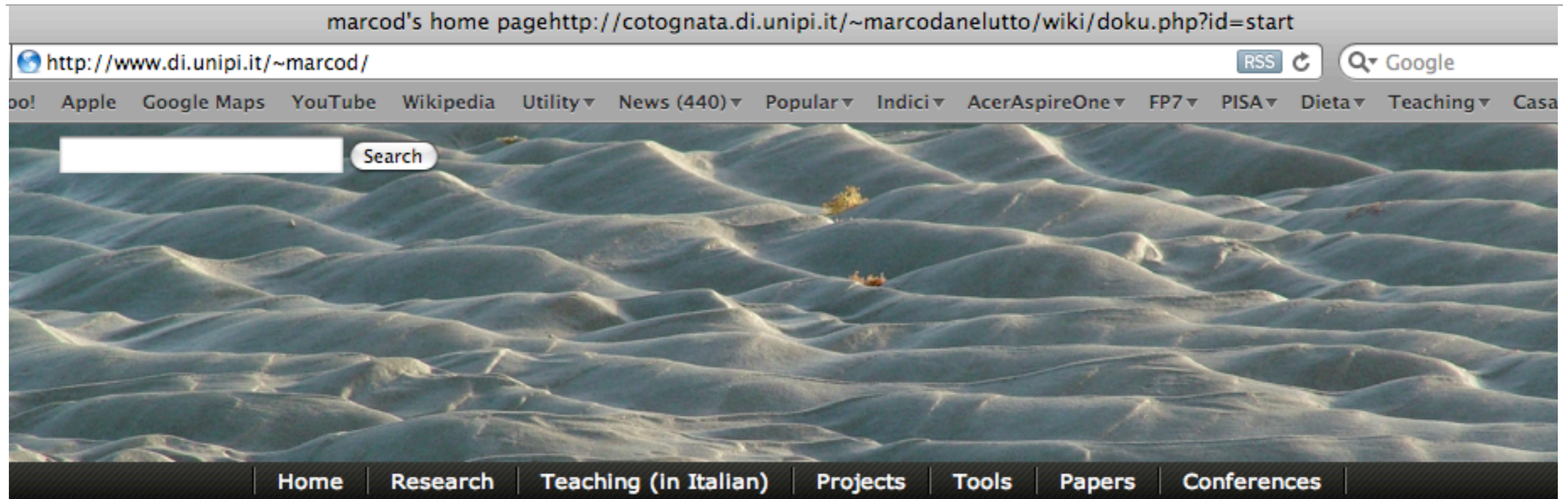
Unsafe layered design

# Layered approach: sample case




Unsafe layered design

# Support material: web site



## Marco Danelutto home page

	
<b>Title</b>	Associate professor
<b>Affiliations</b>	<a href="#">Dept. Computer Science - Univ. Pisa</a> <a href="#">CoreGRID Programming model Institute</a>
<b>Address</b>	Largo Pontecorvo 3, 56127 PISA, Italy ( <a href="#">directions here</a> )
<b>Phone</b>	Phone: +39 050 2212742 Fax: +39 050 2212726





# Support material: web site

Home | Research | Teaching (In Italian) | Projects | Tools | Papers | Conferences

## Attività didattica/Teaching Activity home page 2009-2010

### Corsi A.A. 2009-2010

- **Laurea in Informatica, classe L-31** : [Architetture degli elaboratori](#) corso B, secondo anno, 9 CFU. Il corso inizierà a fine settembre e terminerà a maggio.
- **Laurea Magistrale in Computer Science and Networking** (Laurea Interateneo Università di Pisa (Scienze e Ingegneria) e Scuola Sant'Anna): [Distributed Systems: paradigms and models](#), first year, 9 credits. This course will be in English. It will start in September and end in December (first "semester"). [Here](#) you can find directions to the main buildings relevant to the Master activities.

### Avvisi/News

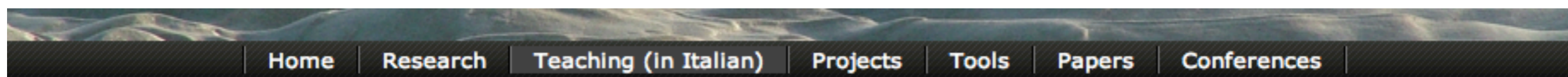
Italiano	English
<i>Dall'A.A. 09/10 gli annunci saranno in inglese, se riguardano il corso "Distributed Systems: paradigms and models" della LM in Computer Science and Networking</i>	<i>From Academic Year 2009-10, news will be in English when related to the "Distributed Systems: paradigms and models" course of the Computer Science and Networking Master degree</i>

- *Courses of the Computer Science and Networking Master degree will start next tuesday, 21th of September. The Distributed Systems: paradigms and models (DSPM) course will start on September 22, 9am, Aula B1, Polo Fibonacci*

### Orario di ricevimento

Orario	Giorno	Luogo
16.00 - 19.00	Mercoledì	Room No. 342, Dipartimento di Informatica (stanza Danelutto)
(salvo diversa indicazione negli "Avvisi" qui sopra – <i>unless differently stated above</i> )		

# Support material: web site



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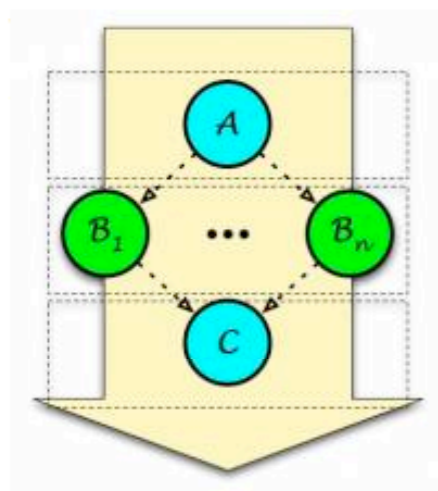
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# Support material: web site

## Distributed systems: paradigms and models

Indice
• Distributed systems: paradigms and models
• News
• Program
• Lessons
• Support material



Teacher: [Marco Danelutto](#)

Assistant: [Patrizio Dazzi](#)

Question time: Wed, 16-19, [room 364](#), Dept. Computer Science

Master (Laurea Magistrale): [Computer Science and Networking](#)

Lesson Timetable		
Day	Hour	Room
Tue	9-11	B1, Polo Fibonacci
Wed	11-13	B, Polo Fibonacci
Thu	16-18	A, Polo Fibonacci

[Modifica](#)

### News

(please consult also the [teacher's news page](#): news related to all courses (e.g. changes in the question time hours, teacher unavailability, etc.) are published on that page.

- SPM course will start next tuesday, Sept. 22, 9am, Room B1, Polo Fibonacci

[Modifica](#)

### Program

The course covers the programming models and the paradigms used with distributed and parallel systems, for both the application and support tool software. Taking into account structured programming models (algorithmical skeletons, parallel design patterns) as well as those models based on components and services, all the problems related to the functional (expressive power, modularity and reuse) and non functional (performance, fault tolerance, adaptivity) concerns will be considered. The lab module will be used to experiment different approaches and solutions on the most common distributed architectures, such as workstation networks, grids and clouds.

[ The course will be logically split into several distinct parts:



# Support material: slides

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- **Slides of the lessons**
  - *PDF (with build stages)*
    - Keynote/Powerpoint slides
    - Handwritten material  
(from lessons,  
“blackboard-like”)
  - *available after the lesson*
    - some material added on-the-fly
  - *posted on the course web site*



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Distributed systems: paradigms and models

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Szyperski 2002

→ unit of independent deployment  
unit of third party composition ←  
no (externally) observable state

↑ (discusse)  
(di molto)

Wikipedia (vedi on line)

\* multiple - use  
non context specific  
composable with other components  
encapsulated (non investigable through interfaces)  
unit of independent deployment and versioning

CCP: ← punto fondamentale



# Support material: lessons

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- **(tentative)**
  - *first time - I'll hopefully succeed using new technology :-)*
- **Audio/video recording of lessons**
  - *published in well know video format on the course web page*
- **Allows to**
  - *recover lost lessons*
  - *re-listen interesting or not so clear pieces of the course*

# Support material: texts

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- **There is no single, official textbook**
  - *notes from the teacher (in particular for the first part: structured programming models)*
  - *parts of books (available through the library or online)*
  - *other material available through web*
- **All items will be available through the web site**
  - *as soon as they are available (in case of material produced to the purpose)*
  - *after lessons (links, web material, reference to book chapters, ...)*





# Question time

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- **Three hours per week**
  - *wednesday afternoon (4 pm to 7 pm)*
  - *shared with graduation thesis students and students of the first degree diploma*
  - *could be increased/moved if necessary*
  - *to be used:*
    - to clarify doubts
    - to discuss exercises
    - etc.

# Lessons

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- **Start with “academic break”**
  - *15 mins after formal time*
- **Mainly given through laptop/beamer**
  - *pre-defined slides or hand made, on-the-fly lessons*
- **Strongly encouraged to interrupt and ask questions**
  - *if really needed*
- **English**
  - *we’ll try to speak slowly, apologize for poor english :-)*
  - *question time in italian, if and only if no “foreign” student present*



# Contacts / addresses

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- **<http://www.di.unipi.it/~marcod>**
  - *follow “Teaching” menu ... or:*  
<http://cotognata.di.unipi.it/~marcodanelutto/wiki/doku.php?id=spm09>
- **[marcod@di.unipi.it](mailto:marcod@di.unipi.it)**
  - *often solves problems without need of face to face meetings*
- **+39.050.2212742**
  - *work phone, to be used in case of need*