

# Embedded & IoT Systems Design (EISD)

Franco Fummi

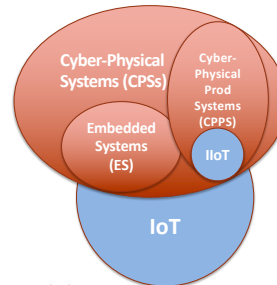
EDALAB



UNIVERSITÀ  
di VERONA  
Department of INFORMATICA

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## Goals



- Methodologies and tools for modelling and design of CPPSs and IIoT:
  - hw/sw modelling
  - hw/sw design
  - IoT sensor-edge-cloud infrastructure
  - CPPs modeling, simulation, integration

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## Embedded & IoT Systems: Where?



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## ES: Historical perspective

- From computer ('60-'80):
  - General purpose systems for solution of general problems
- To digital control systems ('80-'90):
  - Systems dedicated to control and automation
- To distributed systems ('90-'00):
  - General purpose systems and/or dedicated systems through the network
- To embedded systems ('00-):
  - Distributed systems integrated in the environment
- To cyber-physical systems ('10-):
  - Embedded systems integrated with physical systems
- To IoT systems ('20-):
  - Smart everywhere

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## Not everything is IoT (or IIoT)

No

Air conditioner activated by smartphone is IoT?

No

Vibration sensors reporting to a PLC is IIoT?

- Air conditioner communication to a service provider for automatically regulating turn on/off according to power consumption from other appliances?

Yes

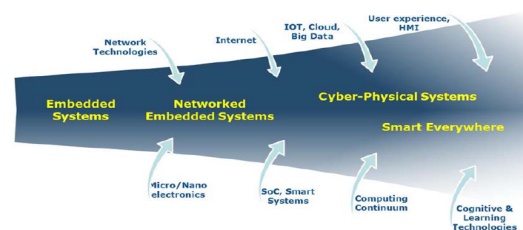
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## How Relevant (II)



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## How Relevantat (I)



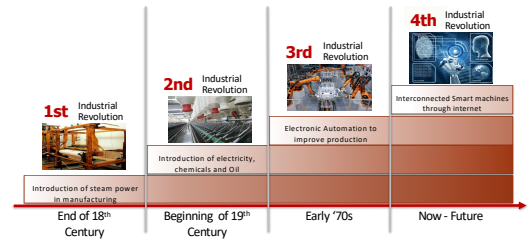
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## How Relevant: The Four Industrial Revolutions



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## ES/IoT: How to design?

- We cannot design embedded systems like general purpose systems
  - Different design constraints, different goals
  - Embedded design is about the system, not about the computer
- E.g.
  - In general purpose computing, design often focuses on building the fastest CPU
  - In embedded systems the CPU simply exists as a way to implement control algorithms communicating with sensors and actuators



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## ES/IoT: Design constraints

- Size and weight
  - Hand-held electronics
  - Weight costs money in transportation
  - Human body cannot eat desktops
- Power
  - Battery power instead of AC
- Harsh environment
  - Power fluctuation, RF interferences, heat, vibration, water, ...
- Safety critical and real time operations
- Low costs

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## ES/IoT: Designer knowledge

- HW architecture alternatives
  - for a correct HW/SW trade-off
- SW design skills
  - lots of languages continuously extending
- HW/SW interaction mechanisms
  - O.S., MW, HdS for efficient SW development
- Network infrastructure
  - all ES are now networked embedded systems
- Computation effort estimation
  - theory is important when used in practice
- Join 3C: computation, control & communication

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## Course Structure

- 35 lectures:
  - 30 theory hours
    - 20 lectures
  - 22 practical hours
    - 11 lectures
  - 6 seminar hours
    - 4 lectures
- People:
  - Franco Fummi (theory)
  - Stefano Spellini (lab. classes)
    - Alessia Bozzini / Marco panato (lab. classes)
  - for practical elaborations
    - Industrial support

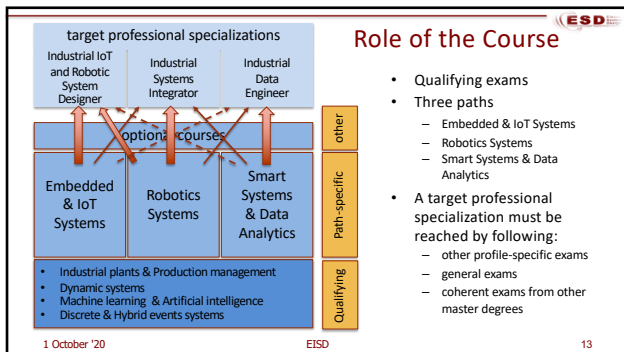


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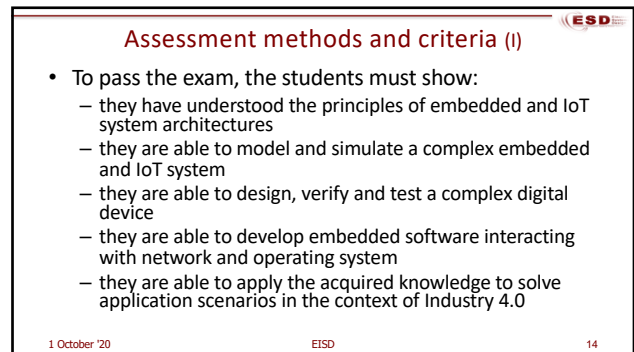
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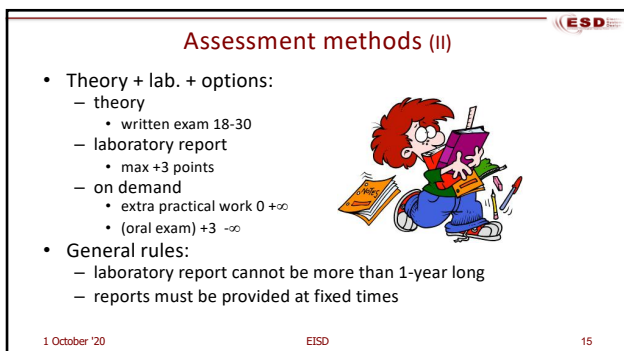
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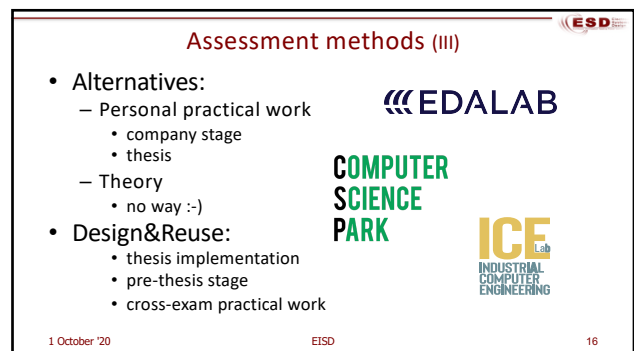
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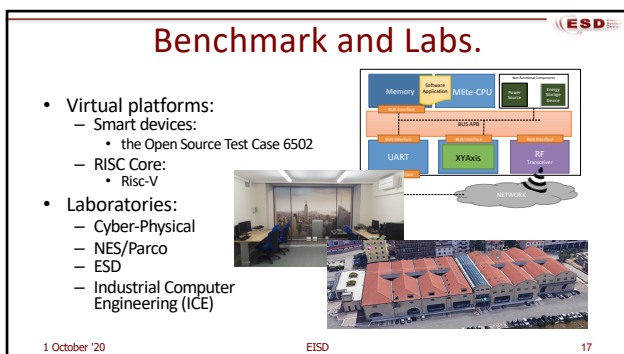
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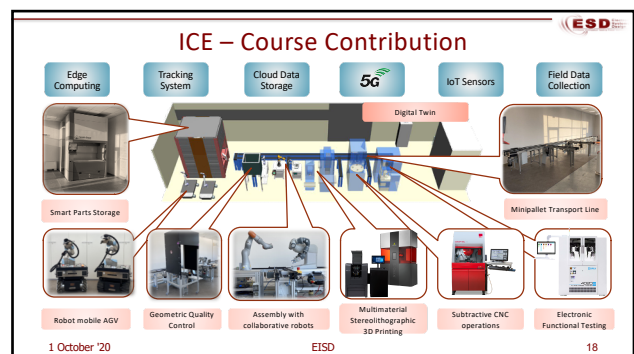
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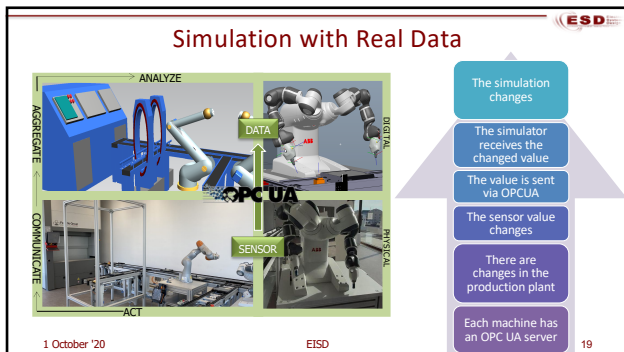
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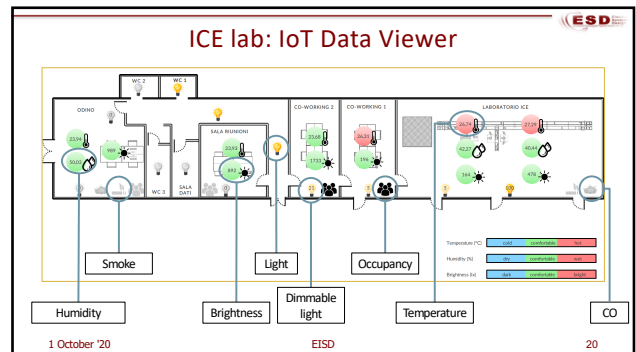
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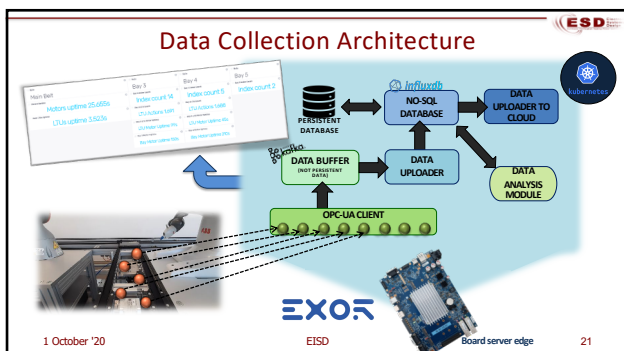
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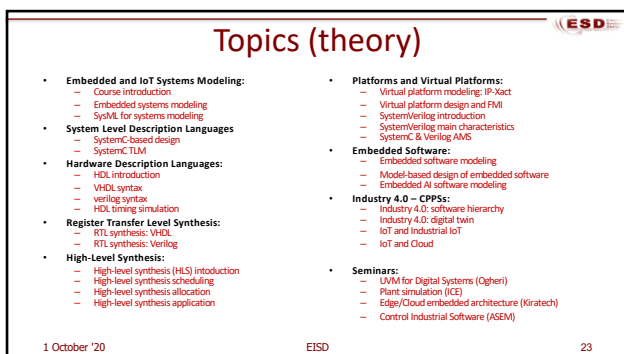
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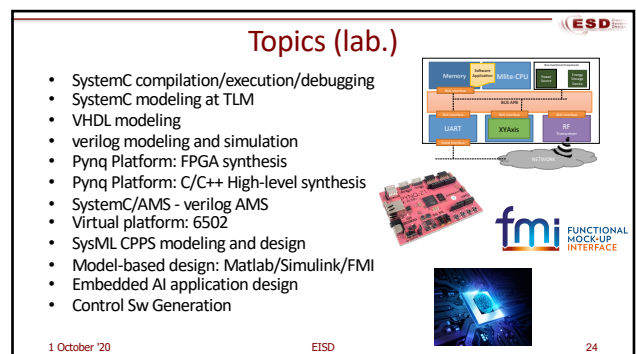
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### Detailed Program

| week | date   | day | lecture | lab. | topic                                                                |
|------|--------|-----|---------|------|----------------------------------------------------------------------|
| 1    | 2-Oct  | Fri | 2       |      | Course introduction: Embedded systems modeling I                     |
| 1    | 5-Oct  | Mon | 1       |      | Embedded systems modeling II                                         |
| 1    | 5-Oct  | Mon | 2       |      | SystemC for systems modeling: SystemC-based design I                 |
| 2    | 8-Oct  | Fri | 2       |      | SystemC-based design II: SystemC TLM I                               |
| 2    | 12-Oct | Mon | 1       |      | SystemC TLM II                                                       |
| 2    | 12-Oct | Mon | 2       |      | HDL introduction: VHDL syntax                                        |
| 3    | 16-Oct | Fri |         |      | HO                                                                   |
| 3    | 19-Oct | Mon | 1       |      | verilog syntax I                                                     |
| 3    | 19-Oct | Mon | 2       |      | SystemC compilation/translation/debugging                            |
| 4    | 23-Oct | Fri | 2       |      | verilog syntax II: HDL timing simulation                             |
| 4    | 26-Oct | Mon | 1       |      | RTL synthesis: VHDL                                                  |
| 4    | 26-Oct | Mon | 2       |      | SystemC modeling abt TLM                                             |
| 5    | 30-Oct | Fri | 2       |      | RTL synthesis: verilog: High-level synthesis (HLS) introduction      |
| 5    | 2-Nov  | Mon | 1       |      | High-level synthesis scheduling&allocation                           |
| 5    | 2-Nov  | Mon | 2       |      | VHDL modeling                                                        |
| 6    | 6-Nov  | Fri | 2       |      | High-level synthesis application: Virtual platform modeling: IP-Xact |
| 6    | 9-Nov  | Mon | 1       |      | Virtual platform design: & VHDL                                      |
| 6    | 9-Nov  | Mon | 2       |      | verilog modeling and simulation                                      |
| 7    | 13-Nov | Fri |         |      | Intermediate exam                                                    |
| 7    | 16-Nov | Mon | 1       |      | SystemVerilog introduction                                           |
| 7    | 16-Nov | Mon | 2       |      | Prima Platform: FPGA synthesis                                       |
| 8    | 20-Nov | Fri | 2       |      | SystemVerilog main characteristics: SystemC & Verilog/AMS            |
| 8    | 23-Nov | Mon | 1       |      | Embedded software modeling                                           |
| 8    | 23-Nov | Mon | 2       |      | Prima Platform: C/C++ High-level synthesis                           |
| 9    | 27-Nov | Fri |         |      | Seminar: UVM for Digital Systems                                     |
| 9    | 30-Nov | Mon | 1       |      | Model-based design of embedded software                              |
| 9    | 30-Nov | Mon | 2       |      | SystemC/AMS - verilog AMS                                            |

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### Teaching supports (I)

- Course web page
  - Detailed program
  - Complete program
- E-learning web page
  - Slides
  - Laboratory instructions
  - Questions/answers
- Book
  - Published
- Seminars
  - Indications during the course

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### More information

<http://www.di.univr.it/~fummi>

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### For the stronger ...

7994

Thursday 10:00 – 11:00

In the corridors... running

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### For the strongest...

7048

On demand

On the e-learning

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alessia.bozzini@univr.it

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