

# Advanced Seminar in Networked Embedded Systems

Winter 2023/24

<https://nes-lab.org/nes-seminar-winter2023/>

Prof. Dr. Marco Zimmerling



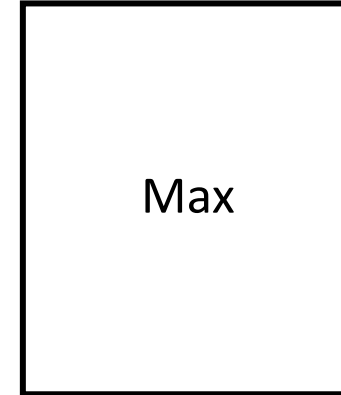
TECHNISCHE  
UNIVERSITÄT  
DARMSTADT

# About me: Marco Zimmerling

- **Since 04/2023:** Full Professor at TU Darmstadt
- **Previously:**
  - Studies at TU Dresden, Uppsala University, and Swedish Institute of Computer Science
  - Internship at IBM Research, Hawthorne, NY, USA
  - PhD at ETH Zurich, Switzerland (2009-2015)
  - Research group leader at TU Dresden (2015-2022)
  - Full Professor at University of Freiburg (2022-2023)



# About the Networked Embedded Systems Lab



- Research group established in 2015
- Focus: Methods and tools for building *dependable*, *efficient*, and *sustainable* cyber-physical and Internet of Things systems
  - Low-power wireless protocol design and analysis
  - Battery-free, energy-harvesting embedded systems
  - Wireless control systems, design for predictability
- Thesis and job opportunities (see <https://nes-lab.org/>)

# Plan for today

1. Teaching goals
2. Organization
3. Available topics

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# Why attend this seminar?

- Learn fundamentals of doing research
  - Read and understand papers
  - Summarize and present complex concepts
  - Give constructive feedback
- Learn about cutting-edge research in cyber-physical systems, wireless sensor networks, and the Internet of Things
  - Maybe your future thesis or HiWi topic
- Learn how to typeset documents in LaTeX

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# Your tasks

- Read a research paper
- Present the paper to your peers
  - Write a 5-page summary
  - Review 2 summaries
  - Give a 15-minute talk
- Active participation
  - Try to attend all sessions
  - Ask critical questions, provide constructive feedback, etc.



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- Typical format at top international conferences



<https://sensys.acm.org/2023/>

## Welcome to ACM SenSys 2023

The 21th ACM Conference on Embedded Networked Sensor Systems (SenSys 2023) introduces a highly selective, single-track forum for research on systems issues of sensors and sensor-enabled smart systems, broadly defined. Systems of smart sensors will revolutionize a wide array of application areas by providing an unprecedented density and fidelity of instrumentation. They also present various systems challenges because of resource constraints, uncertainty, irregularity, mobility, and scale. This conference provides an ideal venue to address research challenges facing the design, development, deployment, use, and fundamental limits of these systems. Sensing systems require contributions from many fields, from wireless communication and networking, embedded systems and hardware, energy harvesting and management, distributed systems and algorithms, data management, and applications, so we welcome cross-disciplinary work.

# From submission to conference

- Prepare and submit manuscript (i.e., a PDF file) following the instructions in the Call for Papers
- Technical Program Committee reviews all manuscripts that comply with the requirements
  - Typically 3-5 reviews per manuscript
- 15-20% of submissions are accepted to appear in the proceedings and to be presented at the conference
  - 35 accepted out of 179 submissions at ACM SenSys 2023

submission:  
06/2023

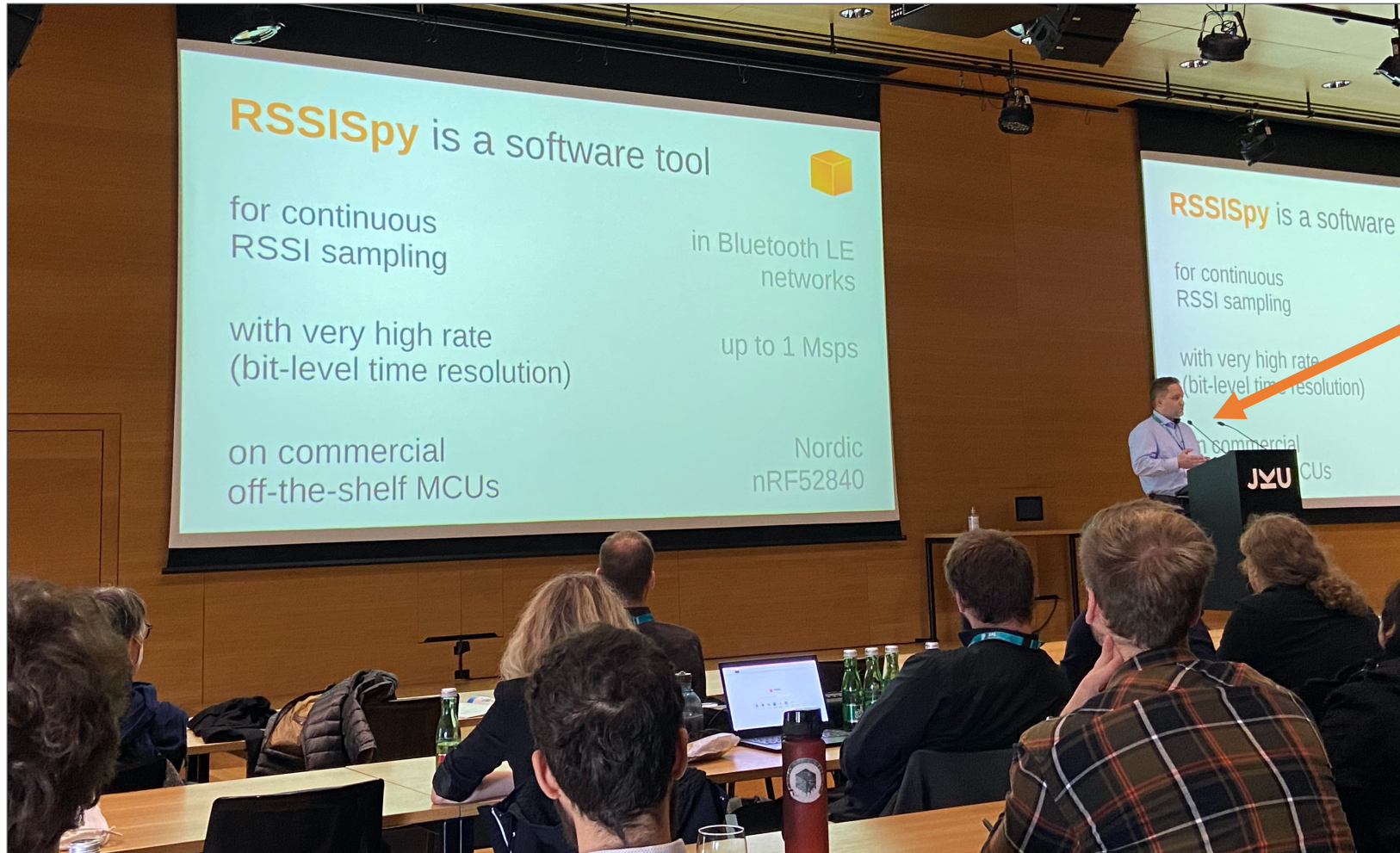


notification:  
09/2023



conference:  
11/2023

# Talks (10–20 min) + Q&A (5 min)



Carsten



# Poster and demo session (2–3 hours)

Posters



Demos

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- Advice today  
**Help from mentor**

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# How does a paper typically look like?

- 10-14 pages in total, font size 9 or 10, double column for conferences papers and single column for journal articles
- Mostly text, but also (illustrative) figures and tables
  - “A picture is worth a thousand words”
- Basic structure:
  - Beginning: Abstract, introduction
  - Middle: Up to the authors
  - End: Conclusions, acknowledgements, bibliography



# Advice on reading a paper

- “How to read a paper” by S. Keshav (2 pages)

<http://ccr.sigcomm.org/online/files/p83-keshavA.pdf>

- “How to read a research paper” by M. Mitzenmacher and N. Ramsey (2 pages)

<https://ccc.inaoep.mx/~esucar/Clases-semidr/Lecturas/ramsey00.pdf>

# Basic approach: Three passes

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  - What is the general problem area? Is it interesting for me?

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- Quickly read rest of the paper (1 hour, at most 2 hours)
  - What are the paper's contributions (i.e., basic idea of proposed method, how is it analyzed/evaluated, how well does it work, ...)
  - Don't be afraid to skip certain parts (e.g., detailed descriptions) and note things you have not yet fully understood

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  - Don't be afraid to skip certain parts (e.g., detailed descriptions) and note things you have not yet fully understood
- Carefully read entire paper again (**3-6 hours or even more**)
  - How does it really work? Need to consult other relevant literature?

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# Summary: Format and rules

- Use LaTeX template available on course website
- In English (British or American, not a mix of both)
- **5 pages** + additional page for references
- Summarize the paper in **your own** words
  - No copy & paste from the paper, except for figures (e.g., results)
  - Must be understandable without consulting the original paper

# Summary: Specific advice

- Content

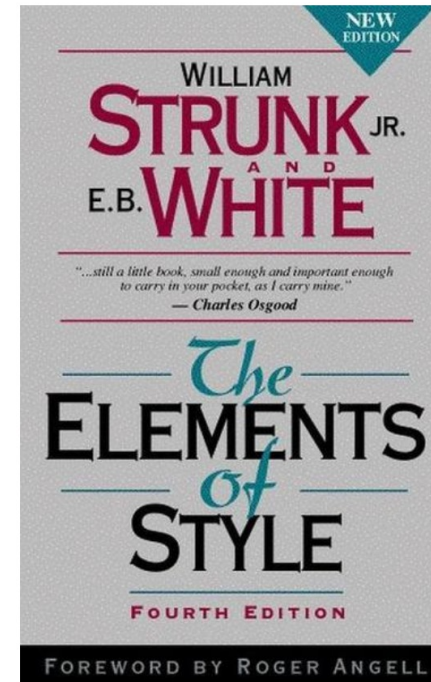
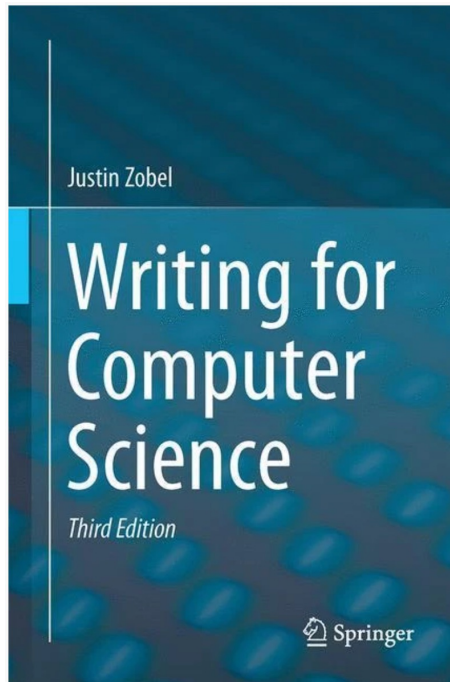
- Imagine you want to persuade someone to read the full paper
- Focus on the core problem, key idea, main result, etc.

- Presentation

- Write in a neutral way (“the authors” or “the experiments”, not “we”)
- Bad English distracts from good content
- Revise, revise, revise

# Summary: General advice on writing

- "Writing for computer science" by J. Zobel
- "The elements of style" by W. Strunk and E.B. White





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# Reviews

- Imitates peer-reviewing process
  - Each student reviews two summaries
- Use HotCRP review management system
  - Mix of concrete questions (multiple choice, free text)
  - About 1 page of English text per review
- Some advice:
  - Be **constructive** and **polite**
  - Your reviews contribute to your grade, not to the reviewee's grade

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# Talk: Format and rules

- Present a recent research paper published at a top venue
- Slides and speech in English
- **15 minutes** + questions
- Prepare **your own** slides
  - No copy & paste from existing slides (e.g., authors' slide deck)
  - You may use results (e.g., plots) and examples from the paper

# Talk: Specific advice

- Content

- Motivation: What is the problem? Why is it important? *high-level*
- Contribution: What is the main novel idea? *some details*
- Conclusion: 1-slide summary *high-level*

- Presentation

- Examples are your secret weapon
- Stick to the time limit
- Practice, practice, practice

# Talk: General advice

- “How to give a great research talk” by S.P. Jones  
<https://www.microsoft.com/en-us/research/academic-program/give-great-research-talk/>
- “Creating effective slides” by J. Doumont *highly recommended*  
<http://youtu.be/meBXuTIPJQk>

# Schedule

- Oct 25: Send paper preferences (1<sup>st</sup>/2<sup>nd</sup>/3<sup>rd</sup> choice) via email to [marco.zimmerling@tu-darmstadt.de](mailto:marco.zimmerling@tu-darmstadt.de)
- Oct 26: Papers assigned and talks (tentatively) scheduled
- Nov 22: Submit summary (HotCRP)
- Dec 6: Submit reviews (HotCRP)
- Dec 20: Submit final version of summary (HotCRP)
- Jan 17 and 24: Talks in S4|14, room 2.1.01

# Interaction with mentor

- Each student will be assigned a mentor
  - Communication primarily via email
  - You may also meet your mentor virtually to clarify questions
- Mentor will provide feedback on your summary
  - Submits review on HotCRP by Dec 6
  - Revise summary based on all reviews
- If you would like to receive feedback on your talk
  - Send slides **at least 7 days** in advance



# Grading

- Summary: 40%
- Reviews: 10%
- Talk: 40%
- Active participation: 10%

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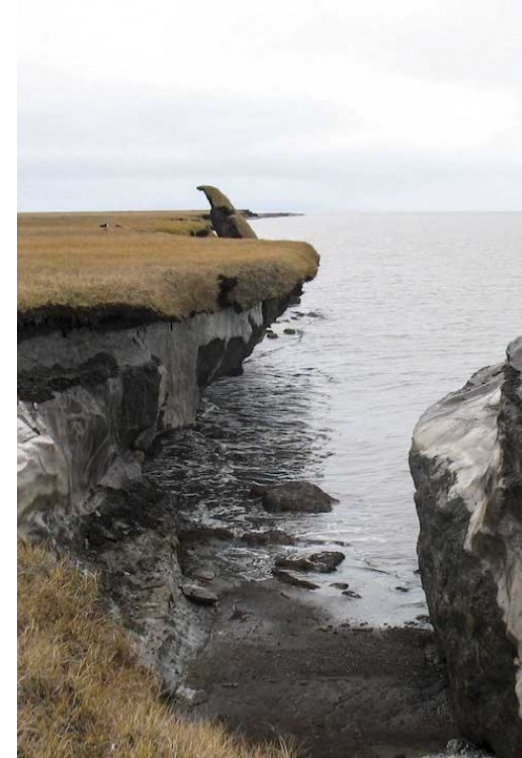
# Example applications



precision  
agriculture



smart  
cities



disaster  
mitigation

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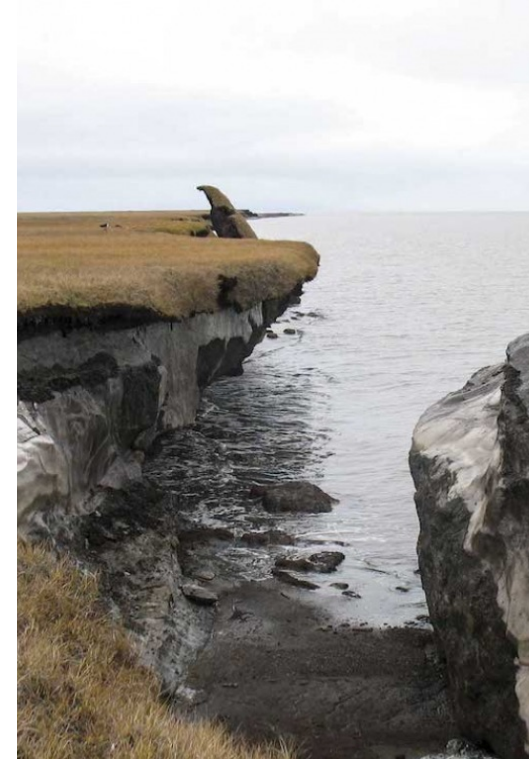
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# Smart cities



- Smart city applications include intelligent transportation, power grid, waste water management, home automation
- Use **distributed sensing**, **decision making**, and **actuation** to, e.g., reduce air pollution and improve quality of life

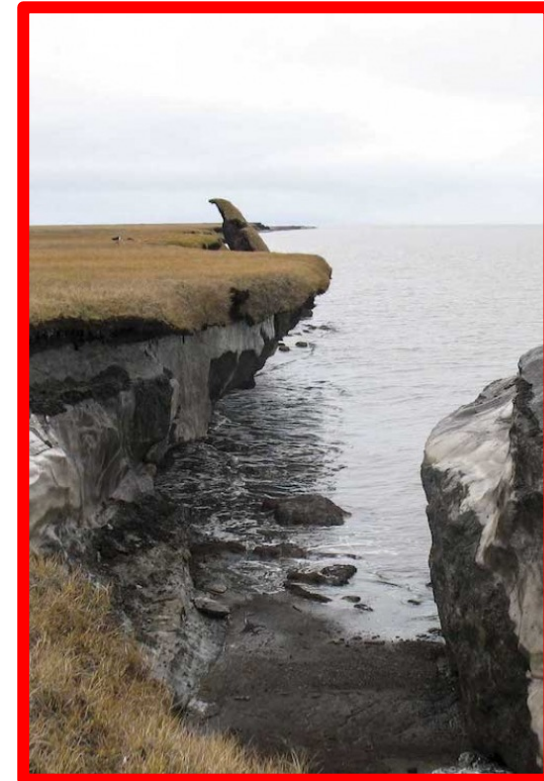
# Example applications



precision  
agriculture



smart  
cities



disaster  
mitigation



# Disaster mitigation



# Disaster mitigation



- Understand, e.g., thawing permafrost in high-alpine regions to predict impending rockfall events
- Use **distributed sensing**, **decision making**, and **actuation** to mitigate harm to humans and critical infrastructure

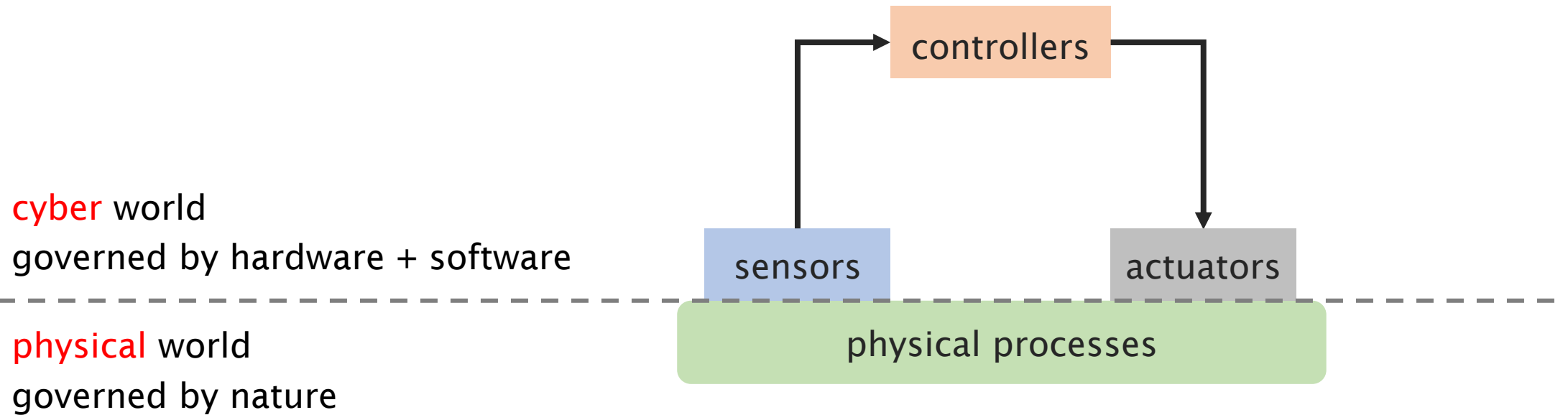
# Cyber-physical systems

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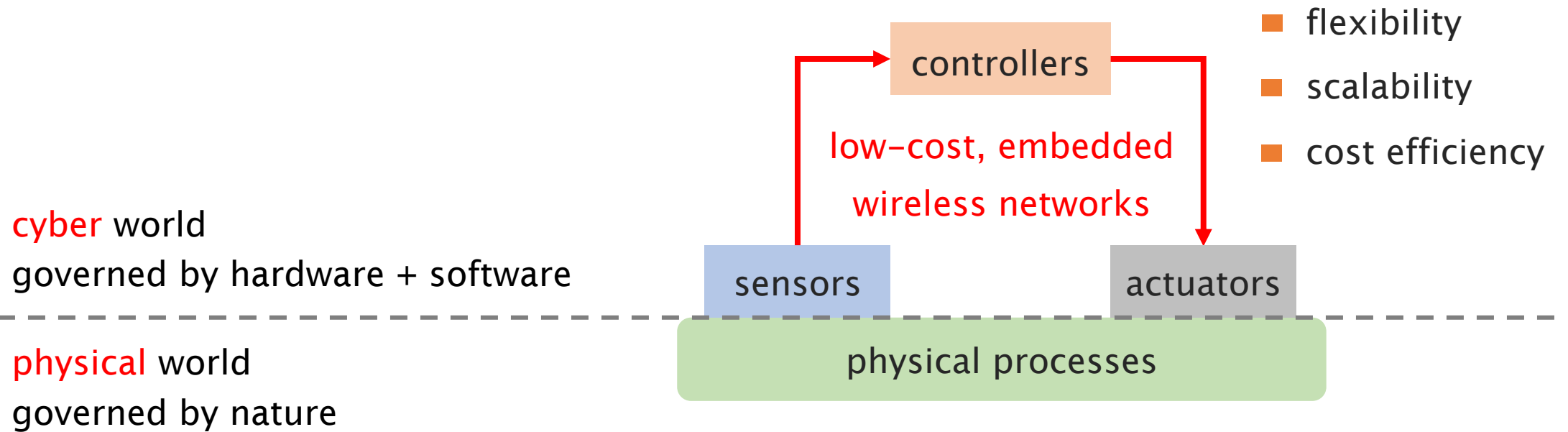
**physical** world  
governed by nature

physical processes

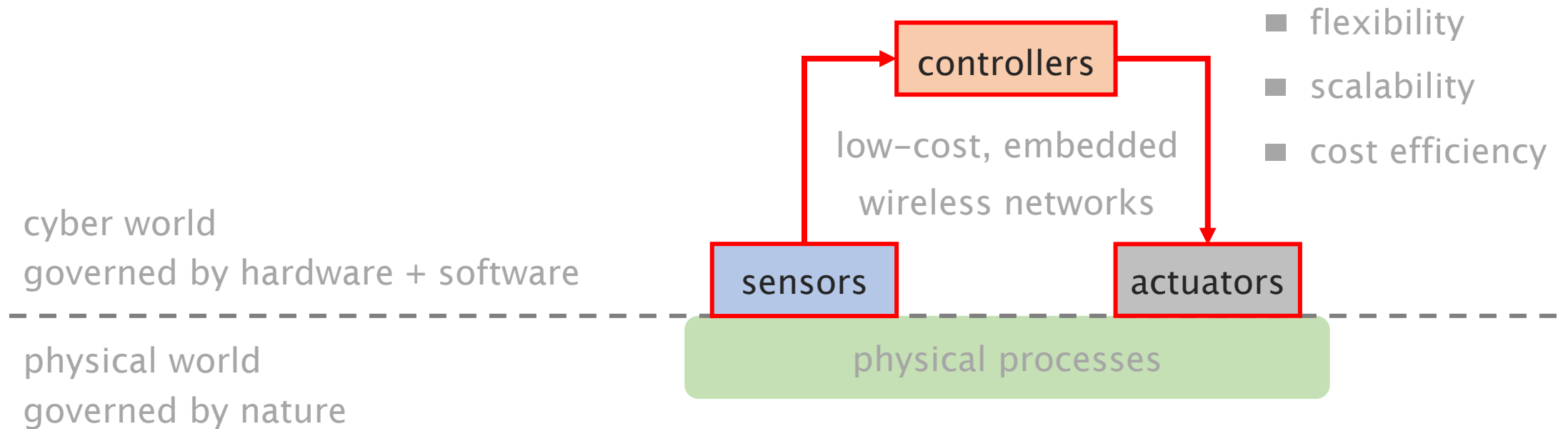
# Cyber-physical systems



# Cyber-physical systems



# Networked embedded systems (NES)



Hardware and software components for sensing, communication, computation, and actuation that enable cyber-physical systems

# Traditional NES



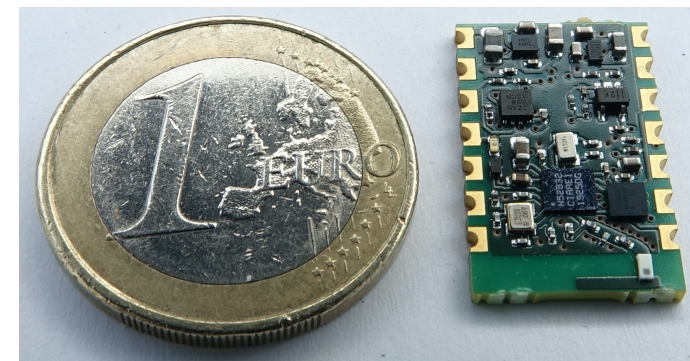
- Anti-lock braking system
- Electronic stability control
- Airbag
- Automatic gearbox
- Smart keys



- Flight control system
- Anti-collision control
- Pilot information system
- Flap control system
- Entertainment system



# Emerging NES



- Trends: Battery-free devices, embedded machine learning, low-power wireless communication, edge computing, etc.



# Topics to choose from

- 10-20 papers published in top international venues:  
<https://nes-lab.org/nes-seminar-winter2023/>
  - Battery-free and energy-harvesting systems
  - Embedded machine learning
  - Wireless communication and networking
  - Localization
  - Sensing and edge computing
  - Emerging applications (e.g., underwater)

# Topics to choose from

- Submit your preferences by October 25, 11:59pm
  - You pick three papers (1<sup>st</sup>/2<sup>nd</sup>/3<sup>rd</sup> choice)
  - By email to [marco.zimmerling@tu-darmstadt.de](mailto:marco.zimmerling@tu-darmstadt.de)
  - Please use the paper numbers listed on the course website
  - We assign one paper and a mentor to each of you