New age, new systems, new services and new challenges for students and teachers of industrial design engineering

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Today's lecture ...

... is a personal view on:

- Influencing trends
- Effects on products
- New design challenges
- Reflection on projects
- Prepare your future

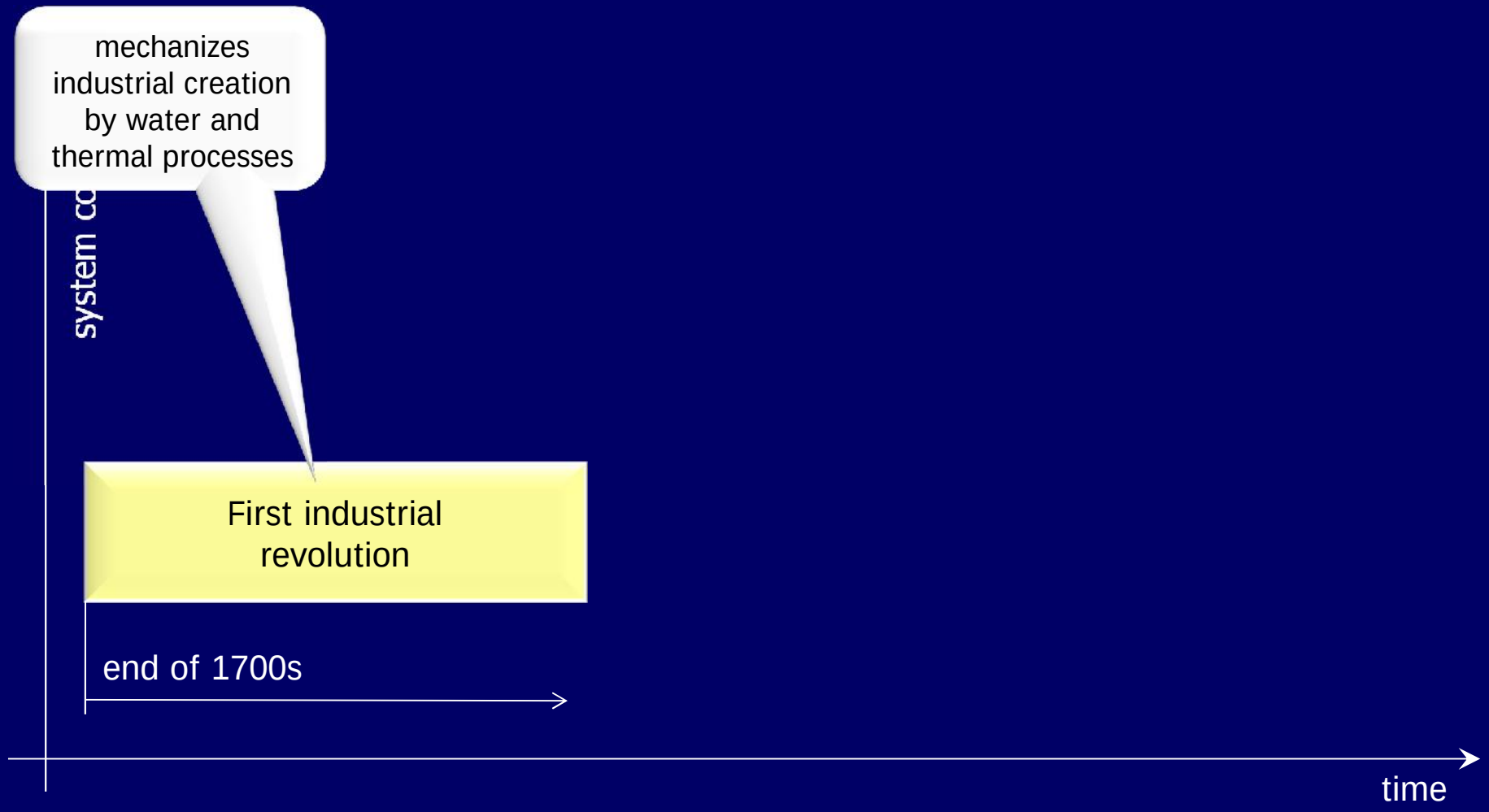
Setting the stage for discussion ...

Traditional customer durables

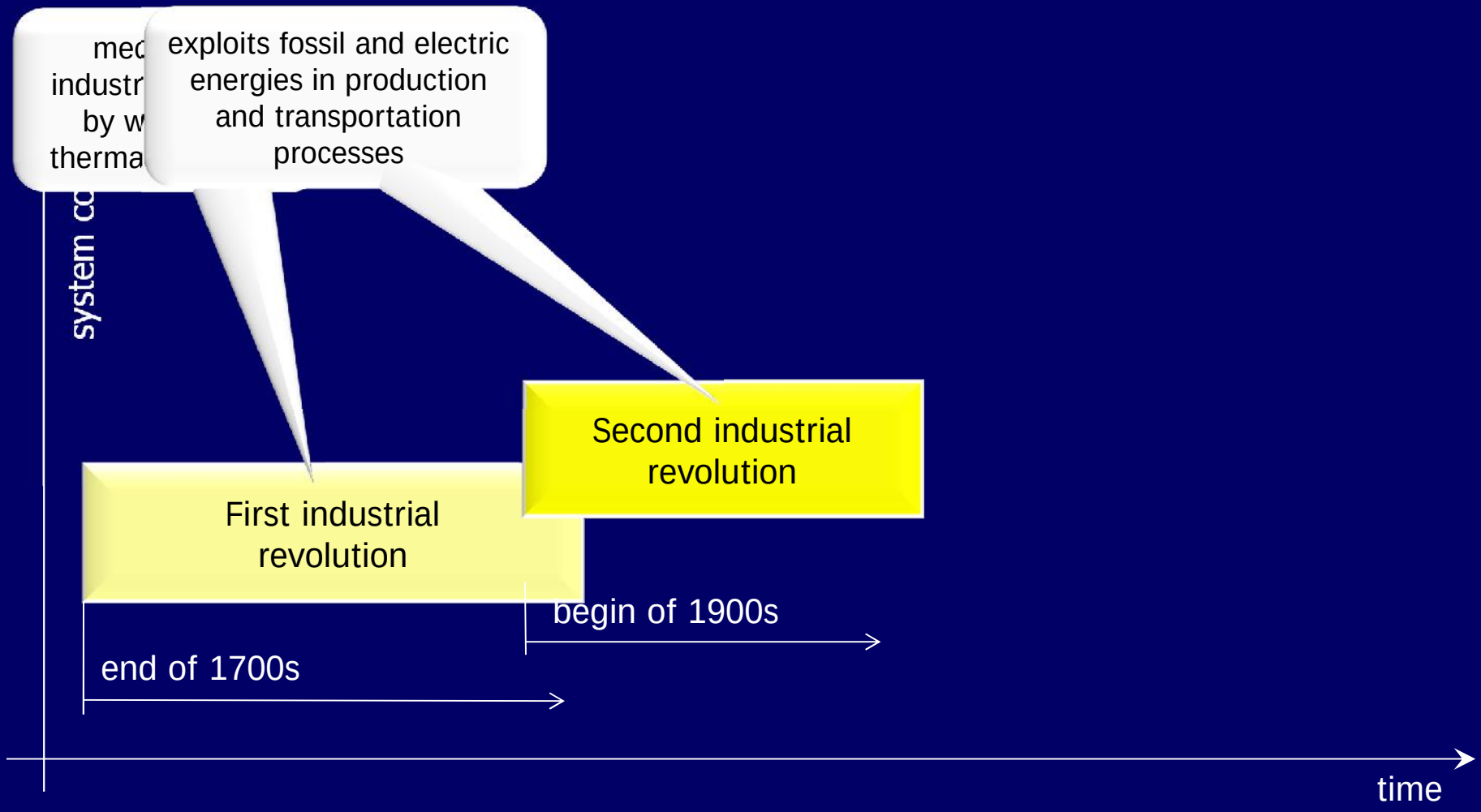
But the change is just around the corner ...

Accelerating industrial revolutions

Accelerating industrial revolutions



Accelerating industrial revolutions



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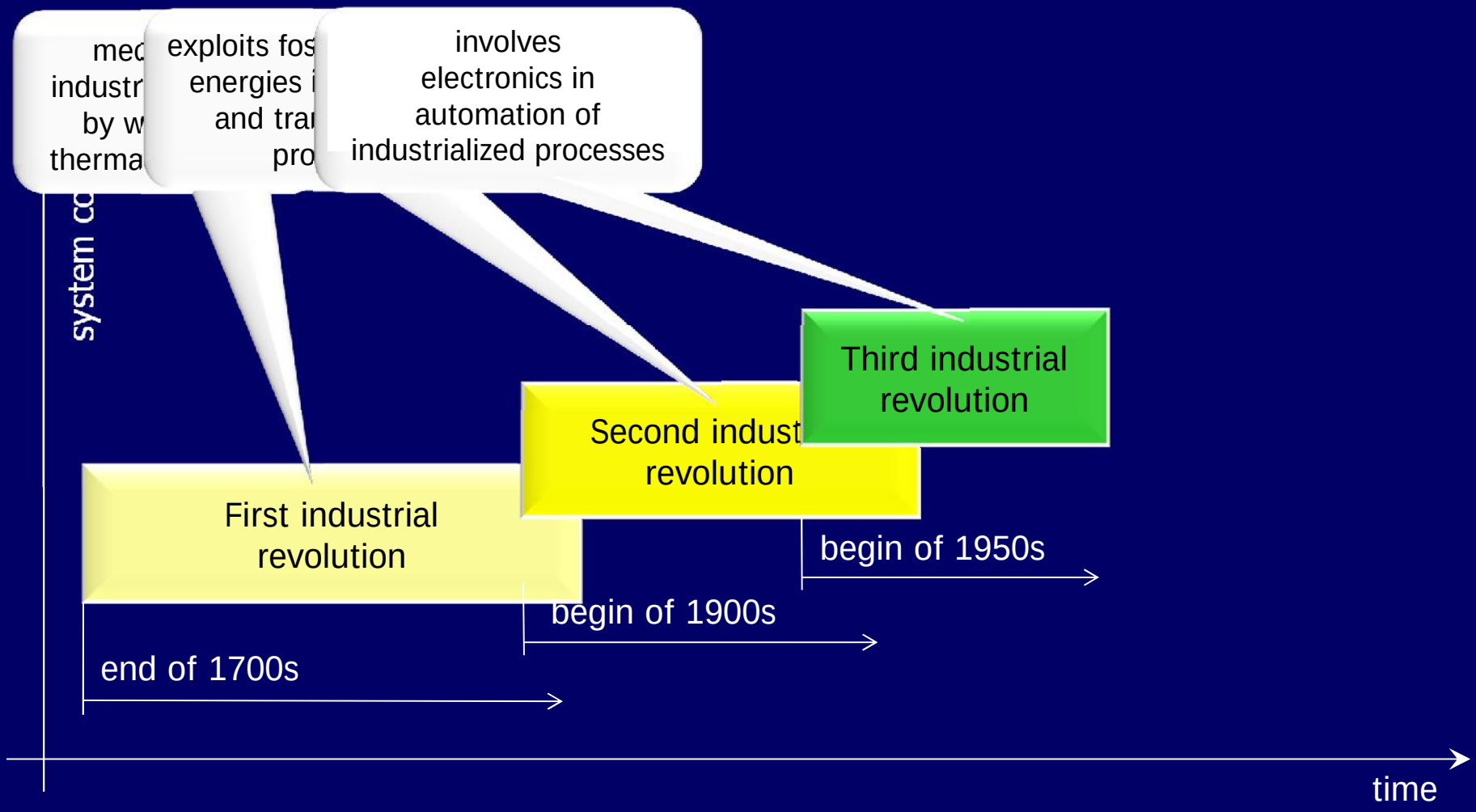

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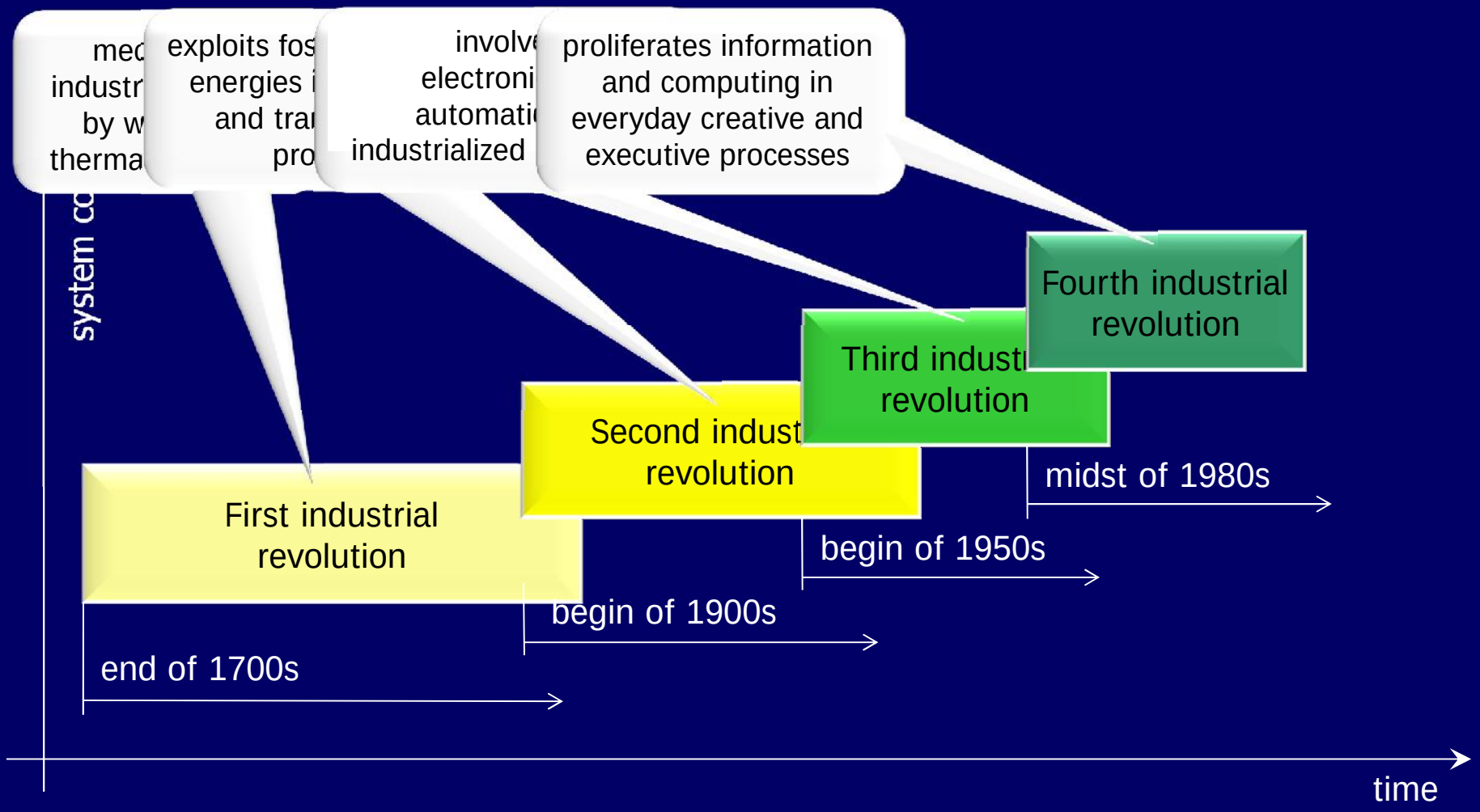

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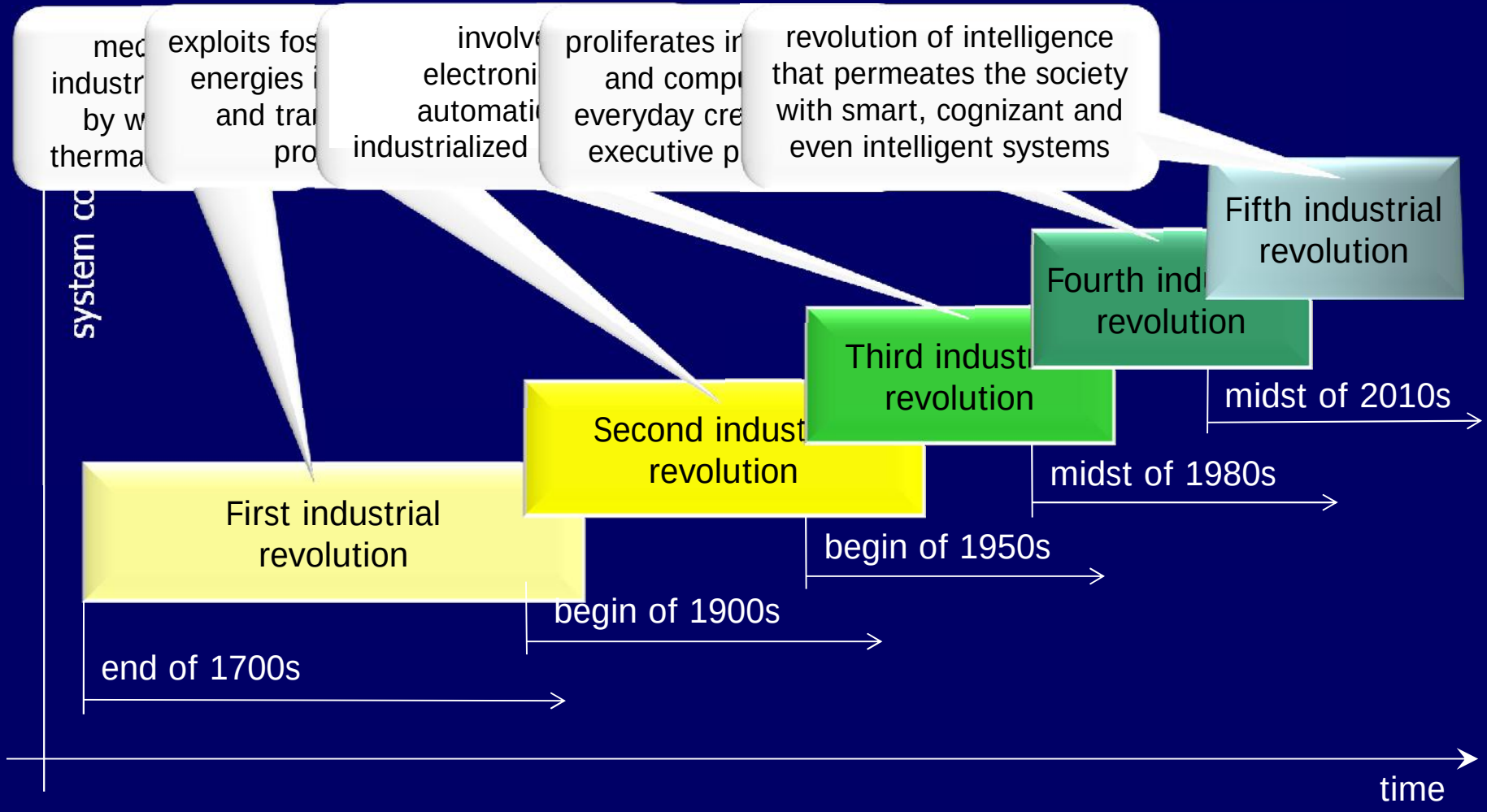
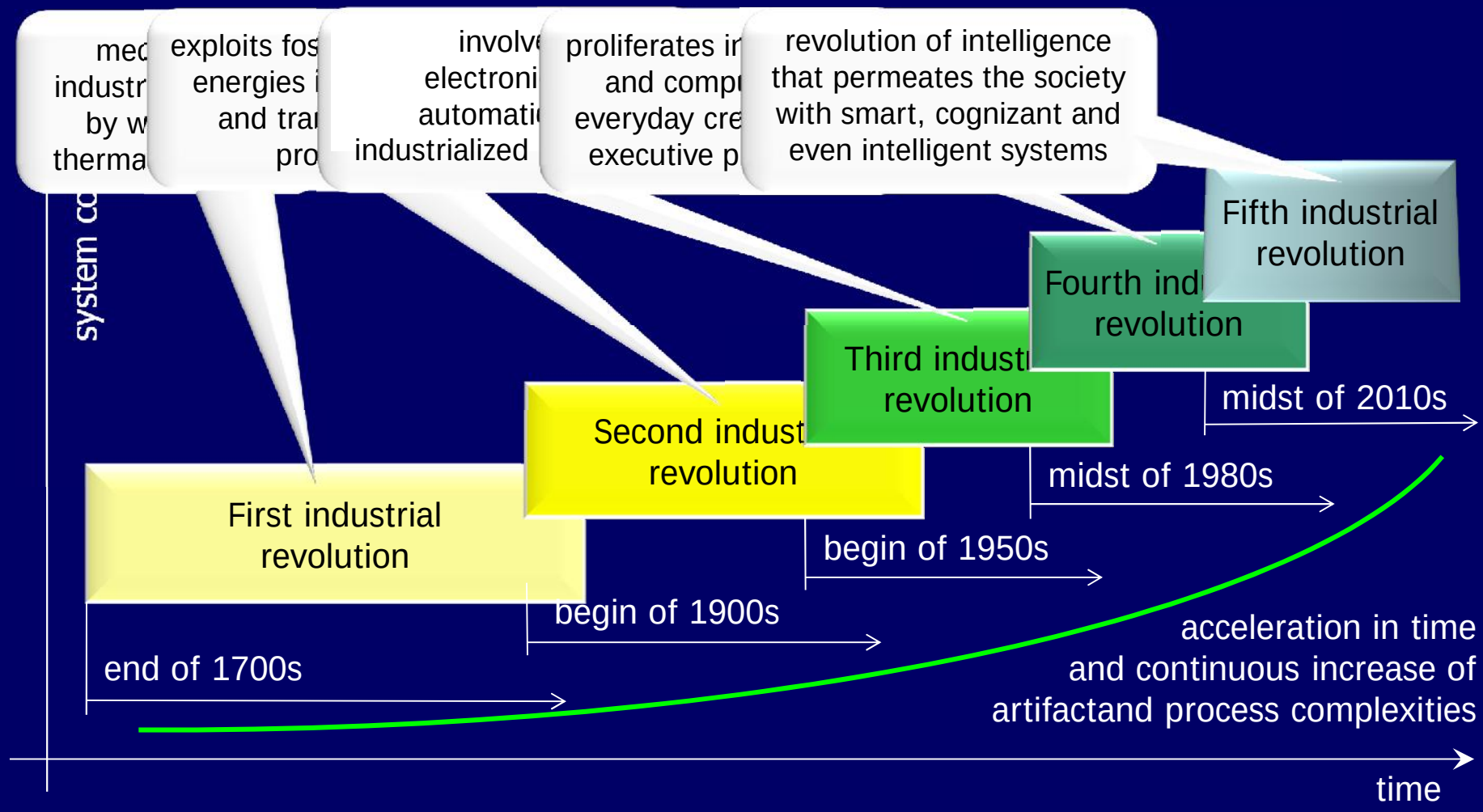
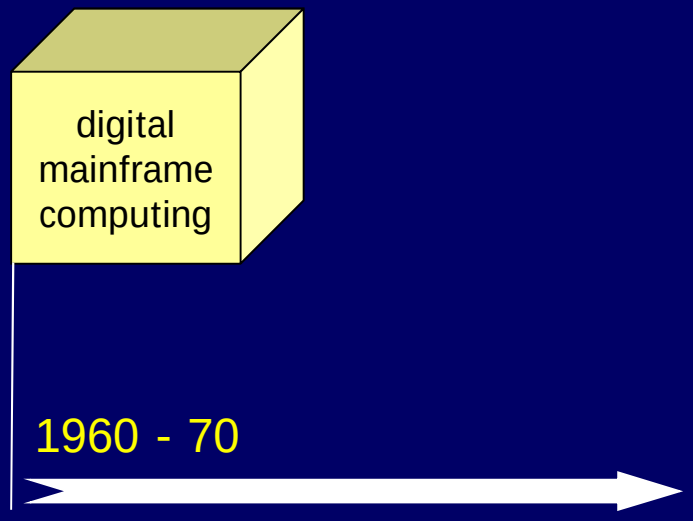


Accelerating industrial revolutions

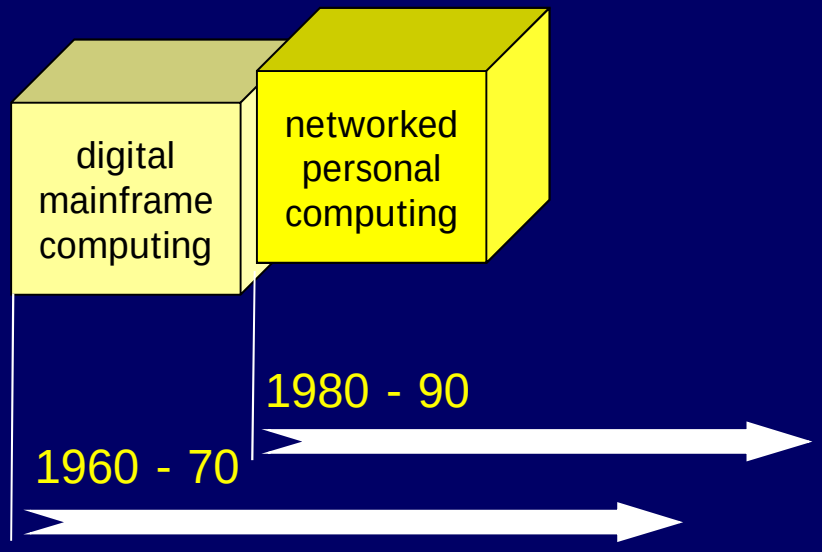


What is the most influential factor nowadays?

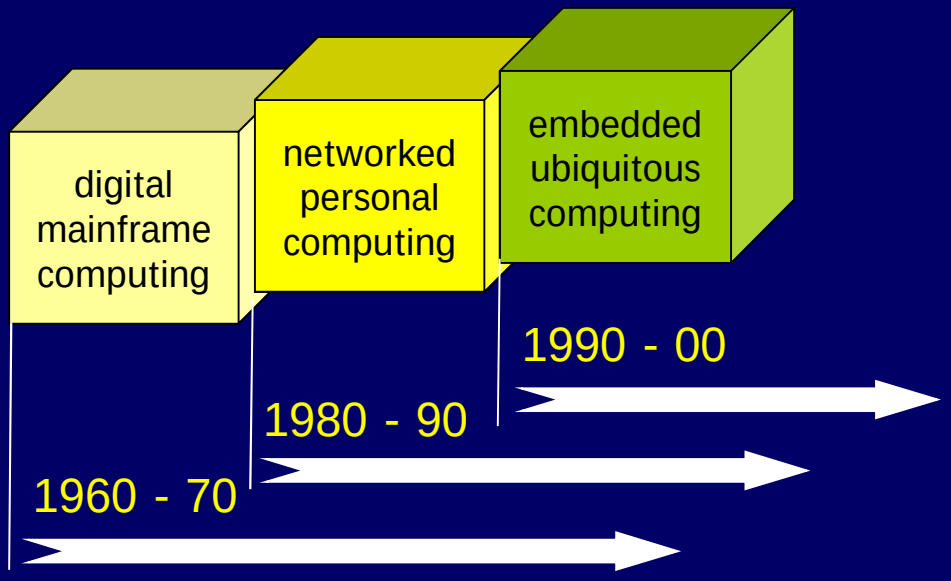
Changing computing paradigms (1)



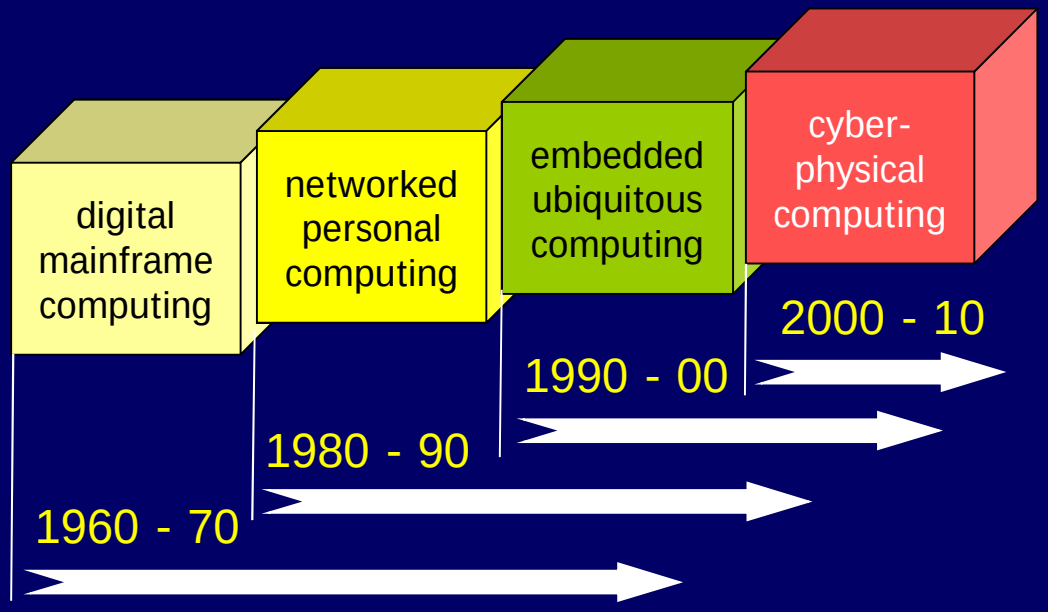
Changing computing paradigms (2)



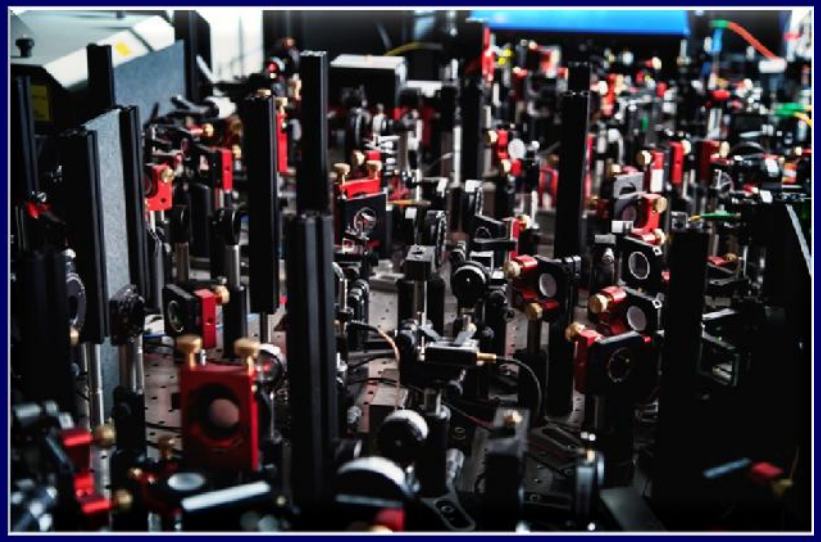
Changing computing paradigms (3)

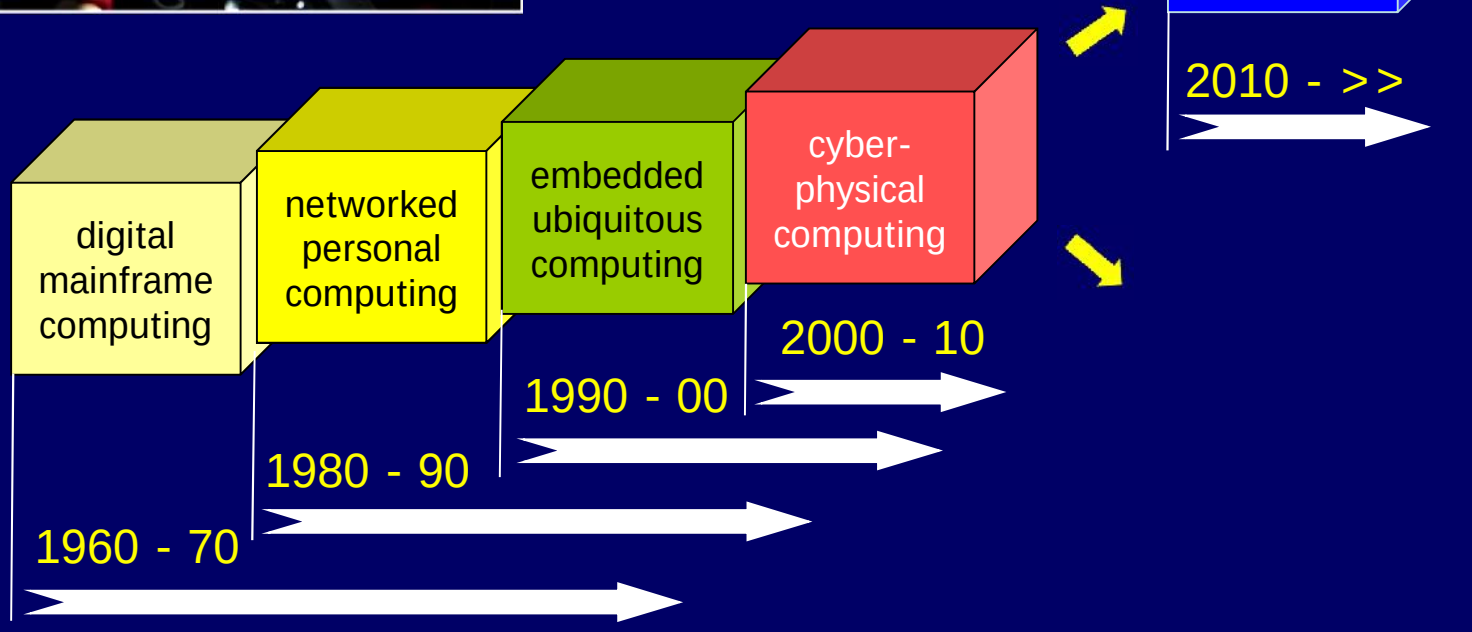


Changing computing paradigms (4)

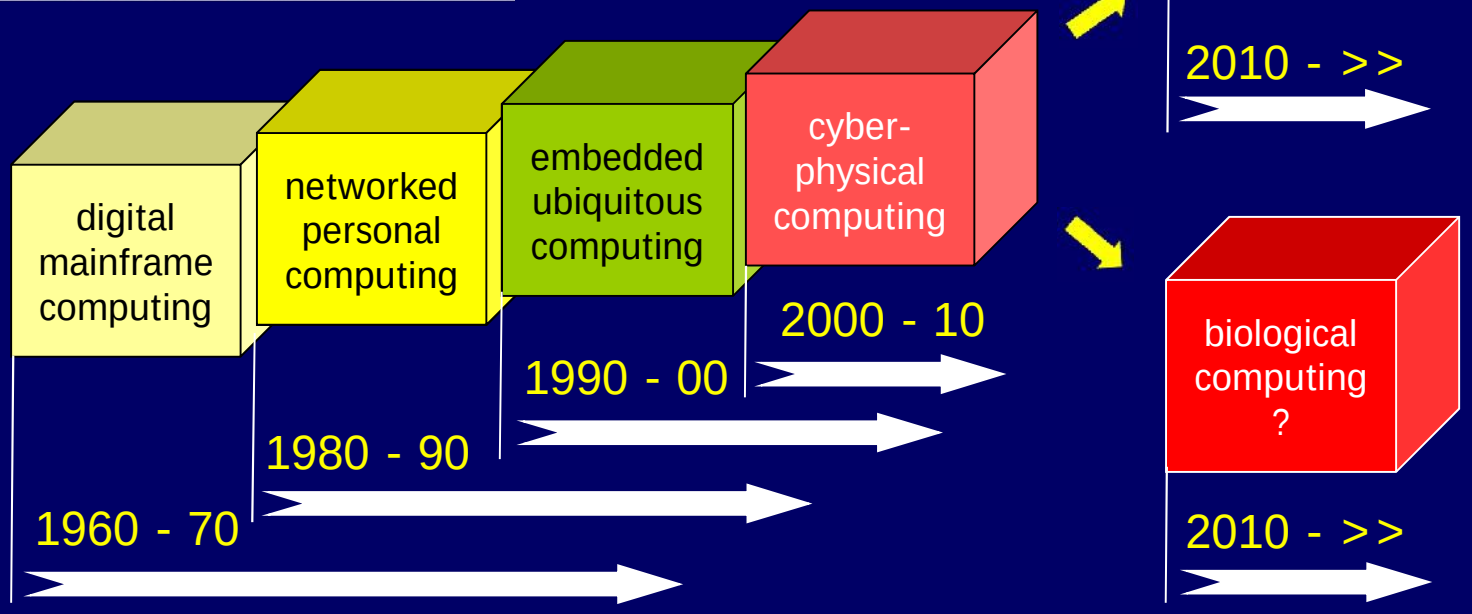


Changing computing paradigms (5)





Changing computing paradigms (6)

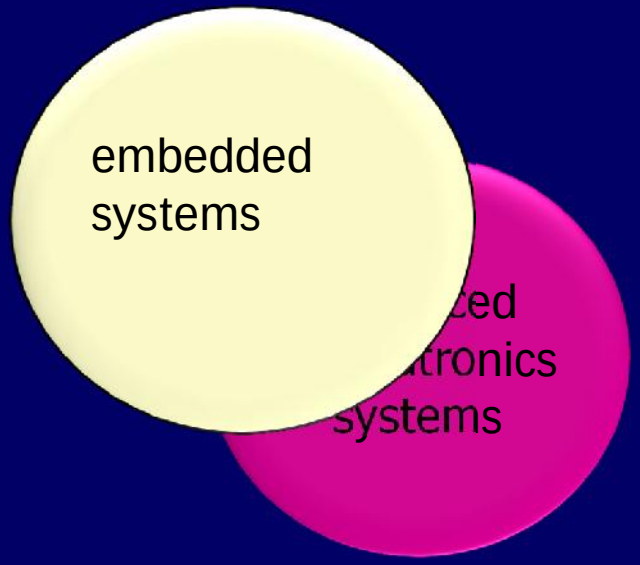


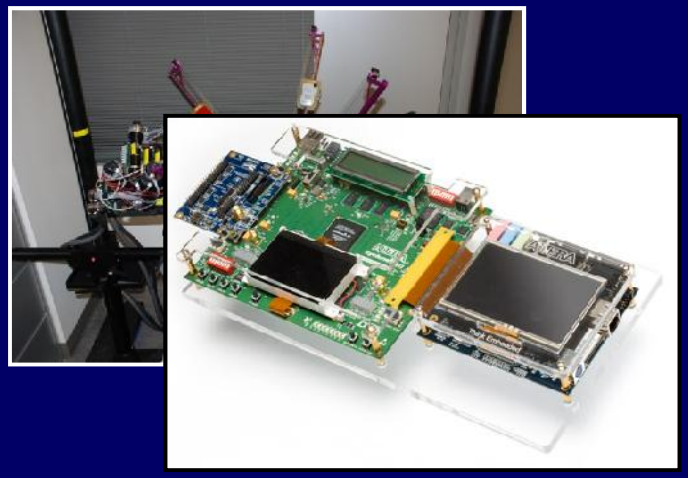
And these influence everything around us!

Shifting paradigms of systems

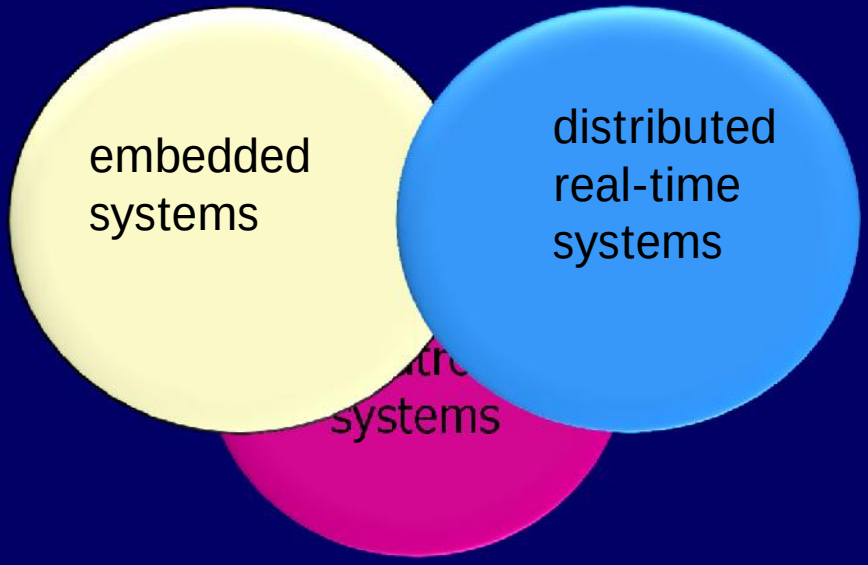
advanced mechatronics systems

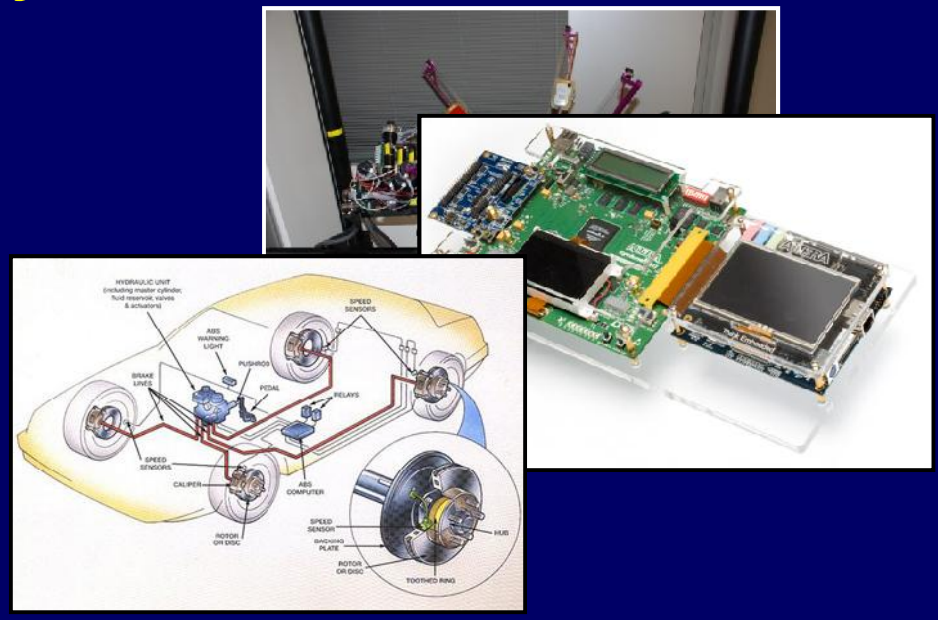
Shifting paradigms of systems





Shifting paradigms of systems





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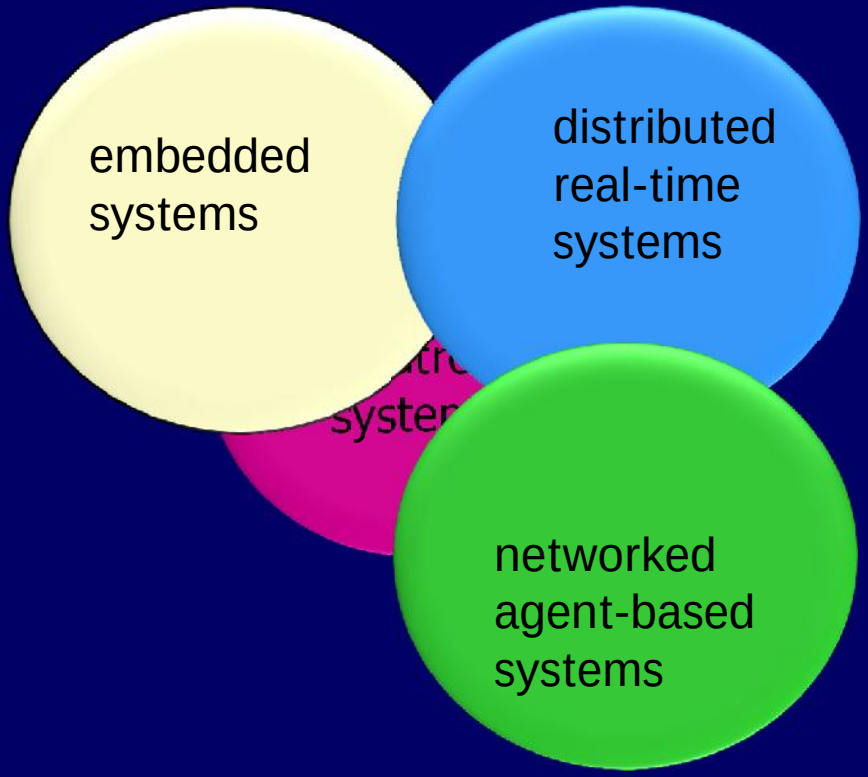

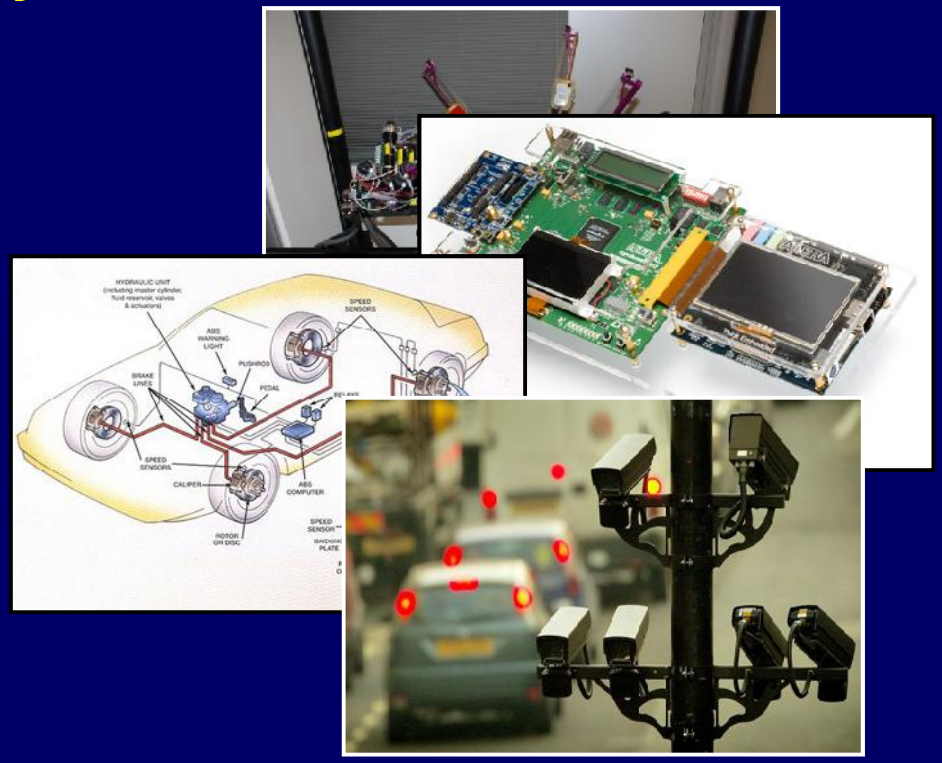

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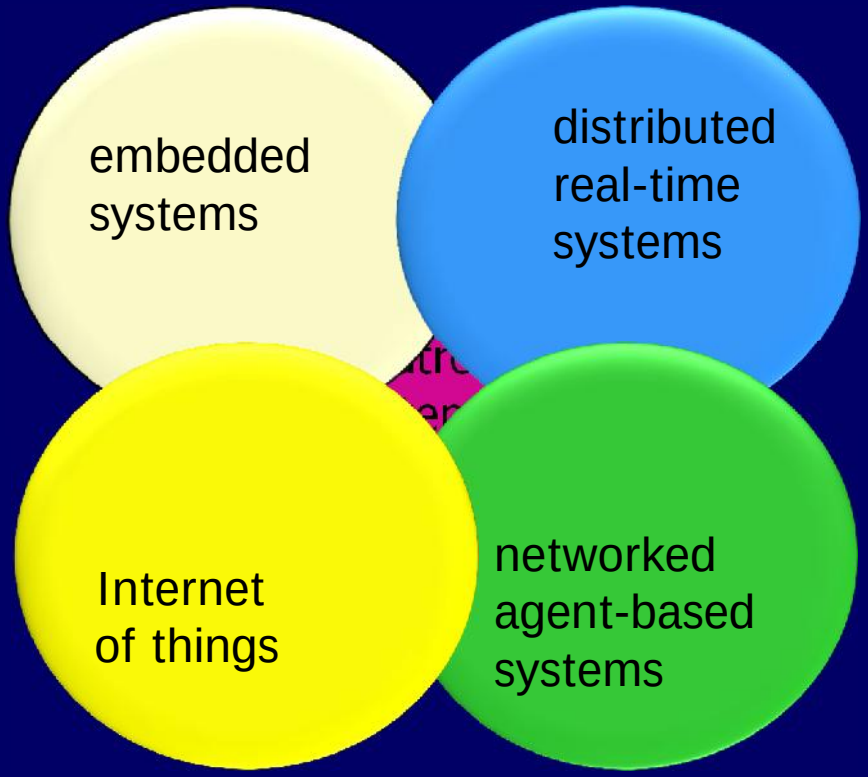

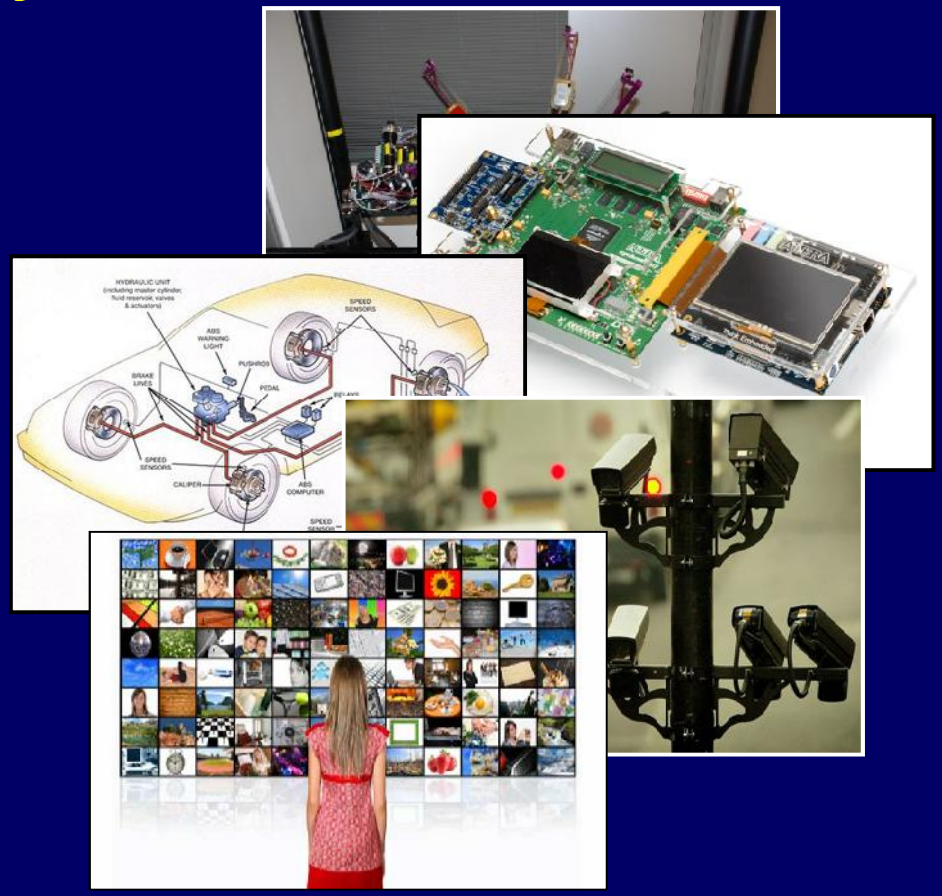

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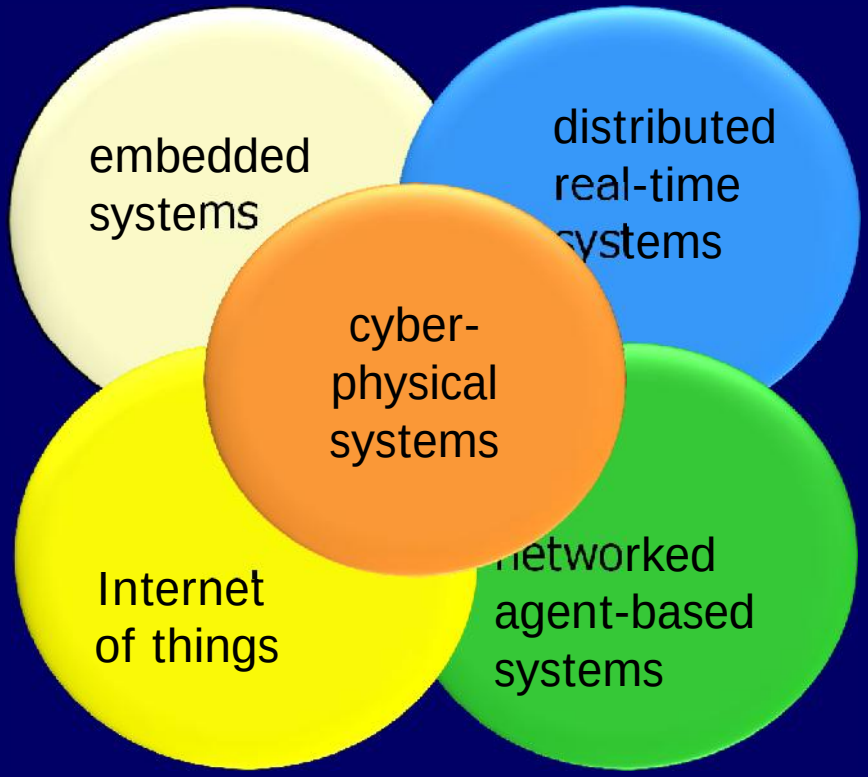
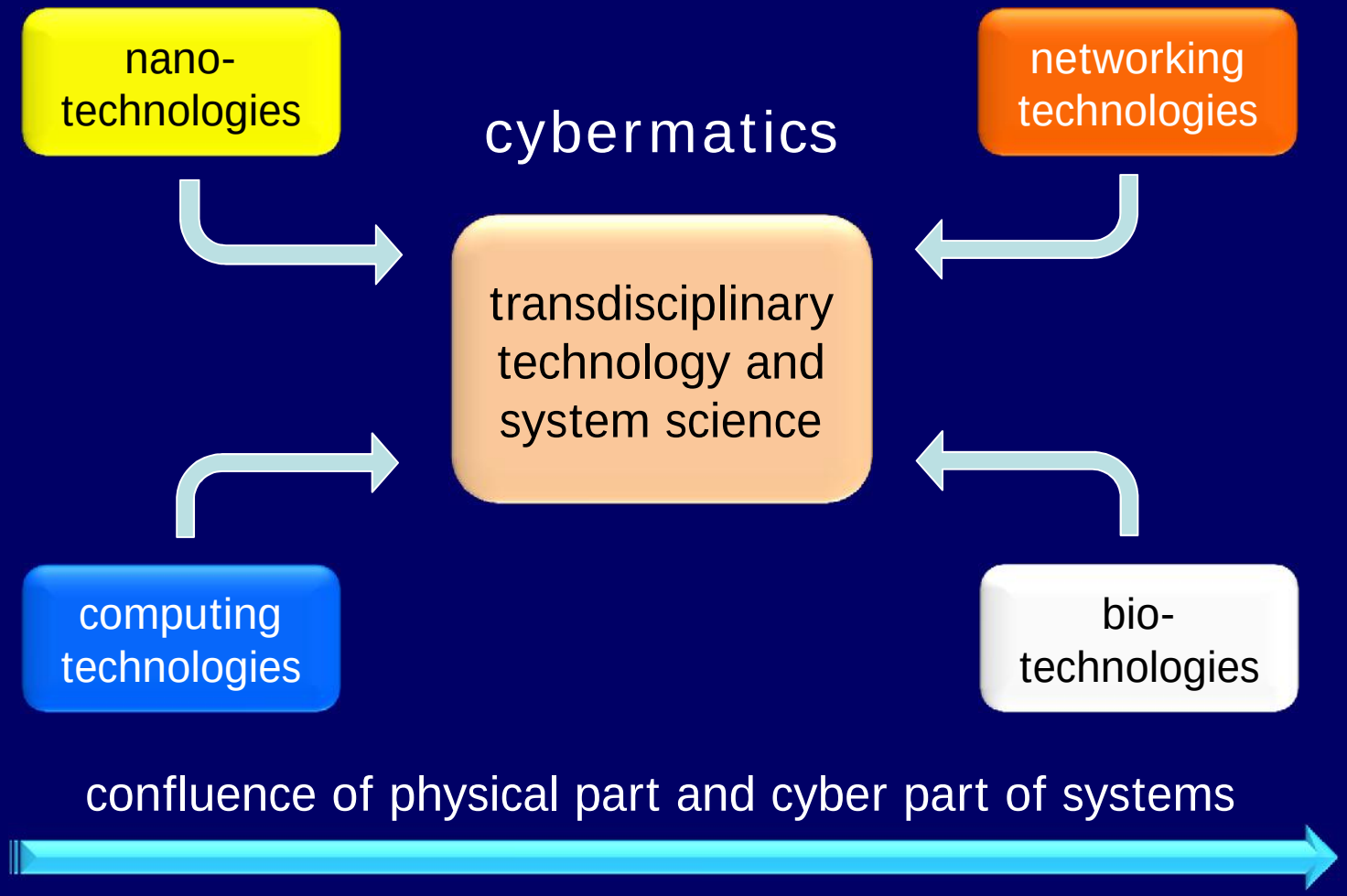


Implication on system development

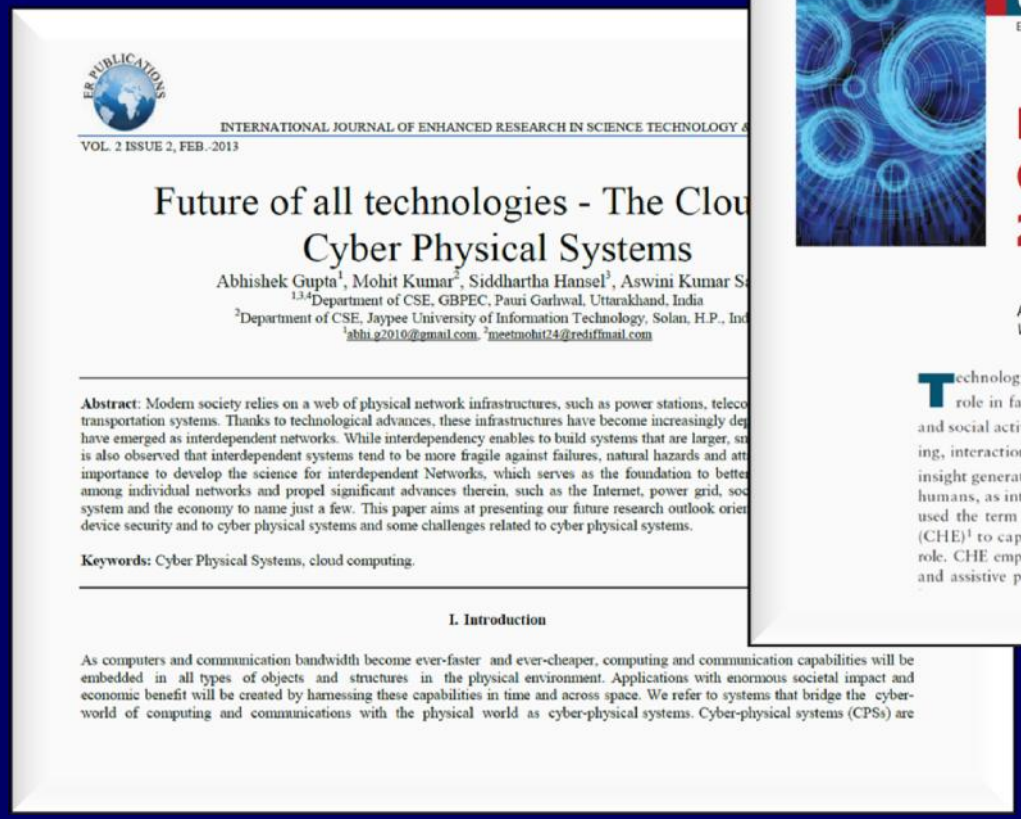


A comprehensive real life example

movie is linked here

What is to be known about cyber-physical systems?

Getting to the center of research ...



INTERNATIONAL JOURNAL OF ENHANCED RESEARCH IN SCIENCE TECHNOLOGY &
VOL. 2 ISSUE 2, FEB.-2013

Future of all technologies - The Clou
Cyber Physical Systems

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Abstract: Modern society relies on a web of physical network infrastructures, such as power stations, teleco transportation systems. Thanks to technological advances, these infrastructures have become increasingly dep have emerged as interdependent networks. While interdependency enables to build systems that are larger, sm is also observed that interdependent systems tend to be more fragile against failures, natural hazards and att importance to develop the science for interdependent Networks, which serves as the foundation to bette among individual networks and propel significant advances therein, such as the Internet, power grid, soc system and the economy to name just a few. This paper aims at presenting our future research outlook orien device security and to cyber physical systems and some challenges related to cyber physical systems.

Keywords: Cyber Physical Systems, cloud computing.

I. Introduction

As computers and communication bandwidth become ever-faster and ever-cheaper, computing and communication capabilities will be embedded in all types of objects and structures in the physical environment. Applications with enormous societal impact and economic benefit will be created by harnessing these capabilities in time and across space. We refer to systems that bridge the cyber-world of computing and communications with the physical world as cyber-physical systems. Cyber-physical systems (CPSs) are

CYBER-PHYSICAL-SOCIAL SYSTEMS

Editor: **Daniel Zeng**, University of Arizona, zeng@email.arizona.edu

Physical-Cyber-Social Computing: An Early 21st Century Approach

Amit Sheth, Pramod Anantharam, and Cory Henson, *Kno.e.sis Center, Wright State University*

Technology plays an increasingly important role in facilitating and improving personal and social activities, engagements, decision making, interaction with physical and social worlds, insight generation, and just about anything that humans, as intelligent beings, seek to do. We've used the term *computing for human experience* (CHE)[1] to capture technology's human-centric role. CHE emphasizes the unobtrusive, supportive, and assistive part technology plays in improving PCS computing requires that we move away from traditional data processing to multitier computation along the data-information-knowledge-wisdom (DIKW) dimension, which supports reasoning to convert data into abstractions that are more familiar, accessible, and understandable to humans.

We illustrate PCS computing for healthcare with a focus on semantic perception,[3] which converts low-level, heterogeneous, multimodal, and contextually relevant data into higher-level abstractions that can provide insights and assist humans

A generic definition

- Cyber-physical systems:
  - manifest as smart networked multi-actor systems
  - are enabled by cyber-physical computing
  - are examples of synergistic/compositional systems

and are characterized by

  - deep diffusion into real-life physical processes
  - multiple sensing-reasoning-adapting-actuating loops
  - dynamic resource and service provisioning
  - applications in human/social/industrial contexts

Examples of CPSs

Air traffic control system

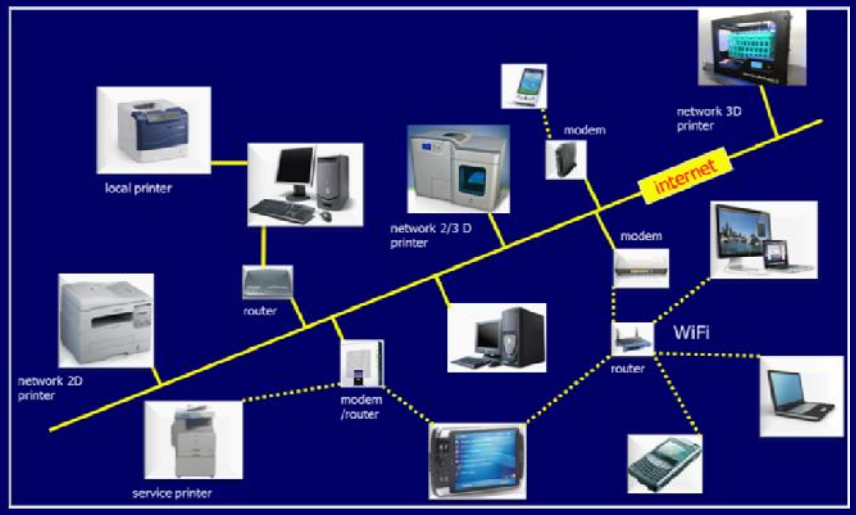
Automated logistics system

Robotized military combat system

Smart electric grid system

Other examples of CPSs

Self-driving car-fleet system



Follow-me 2D/3D printing system

Caregiving assistive robotics system

Stroke rehabilitation assisting system

Penetration into real life processes

- System control is synthesized based on information obtained in run-time and real time from existent real-life processes

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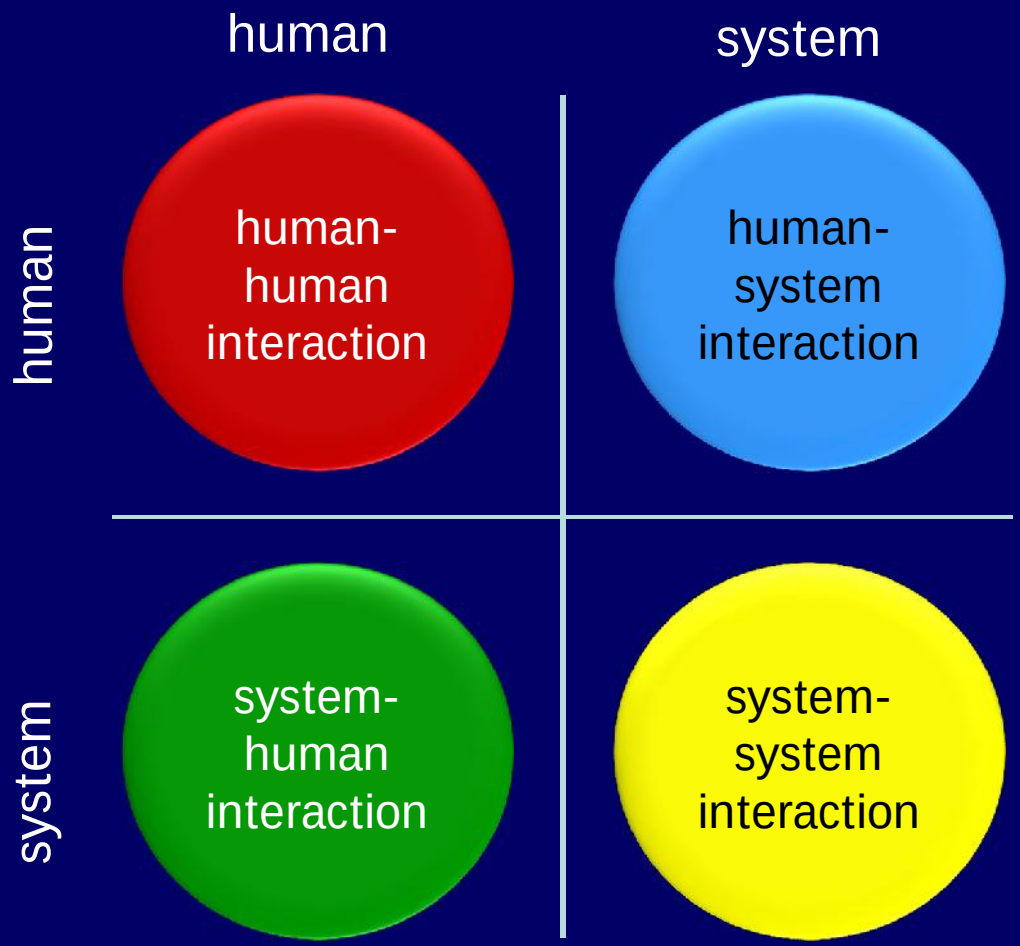
- RTC enables CPSs to adapt (sense, reason, learn, actuate, organize, evolve, reproduce) dynamically and reliably

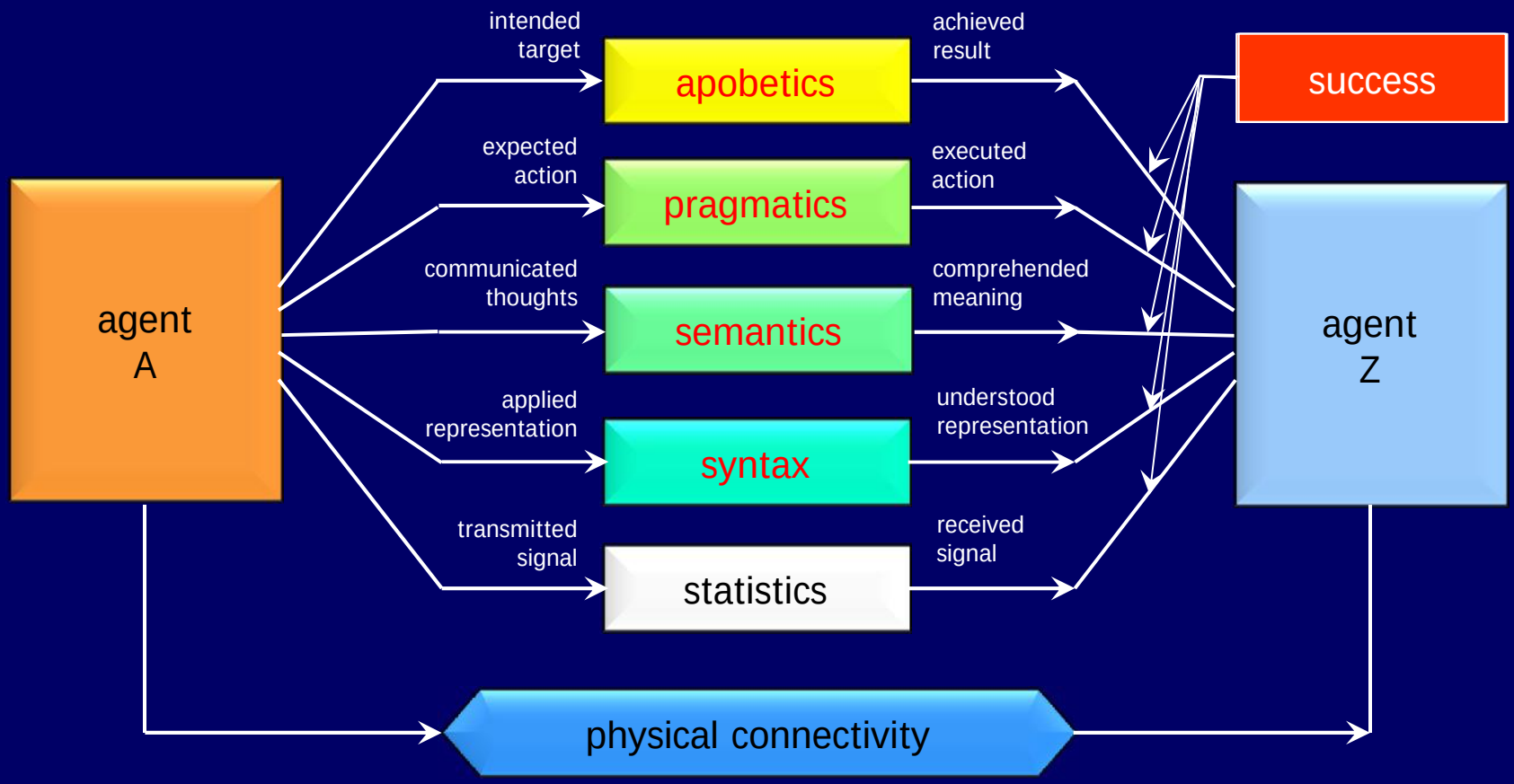
Advanced reasoning model on interaction

Who is taking the initiative to achieve the objective?

The level of interaction also plays an important role



Levels of interaction



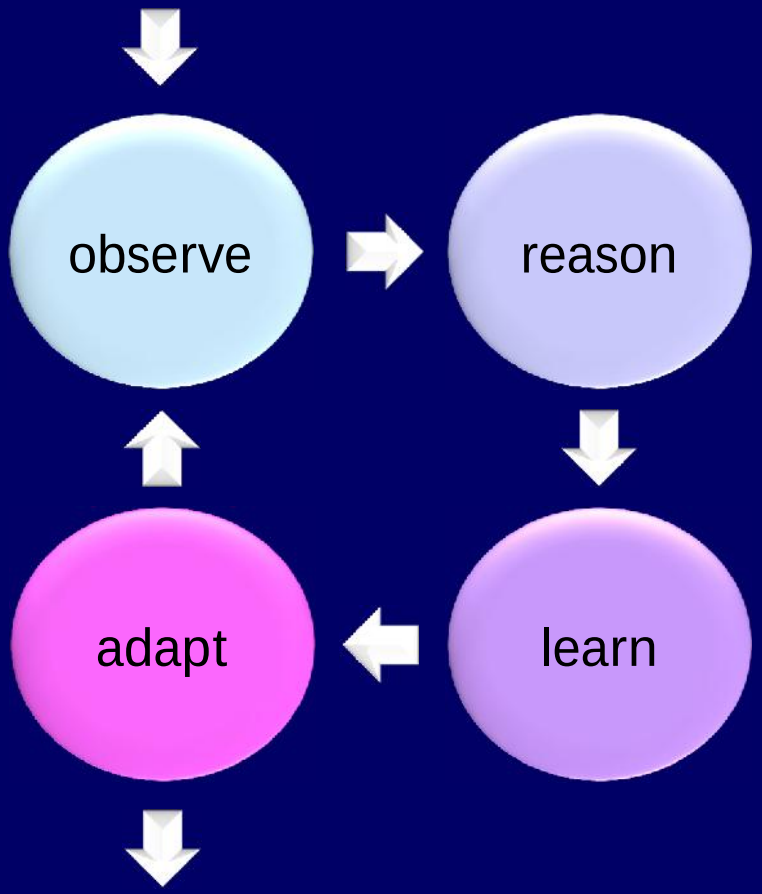
These all come together here ...

movie is linked here

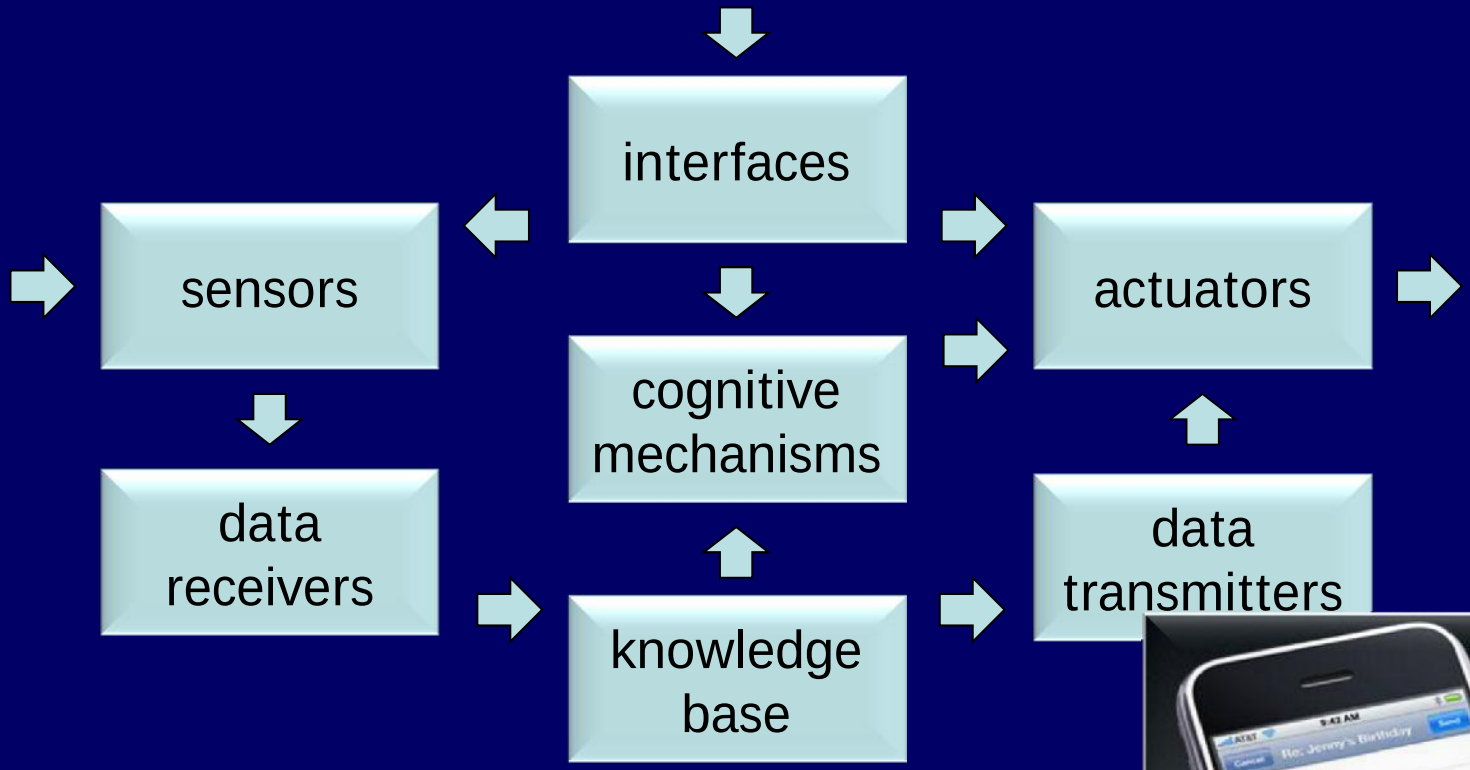
Smart products and serviced will be in the focus

Can you imagine ...

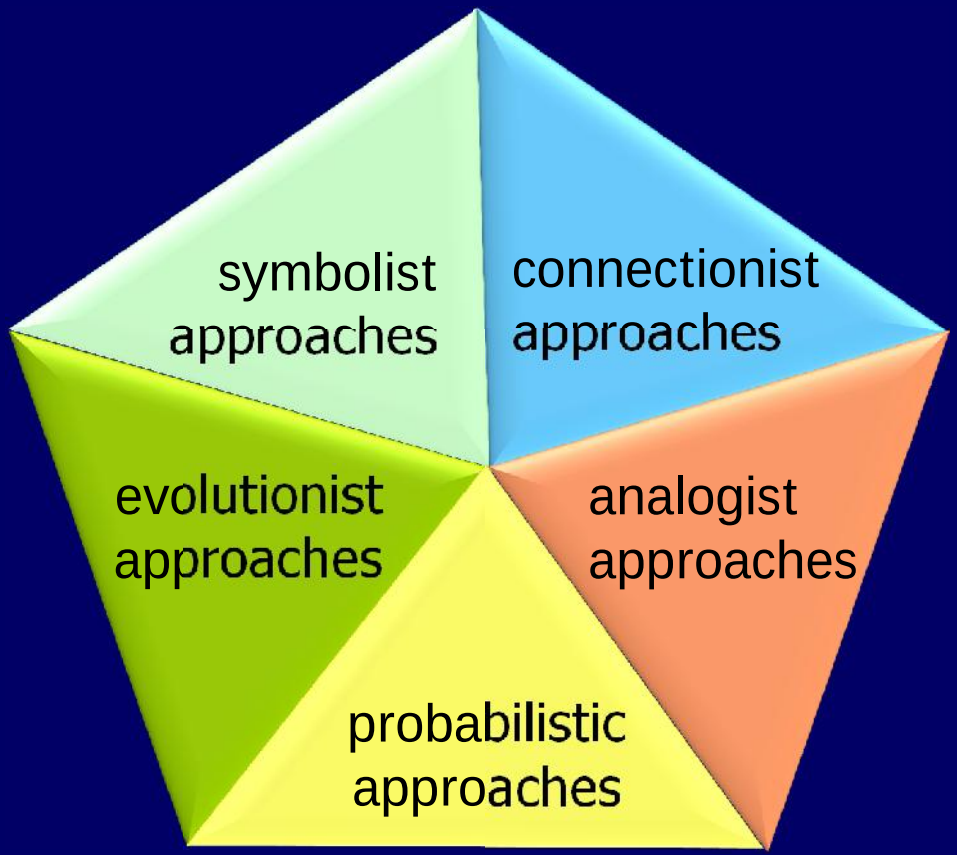
- .... a computer-controlled system in which information processing is not (or is not completely) preprogrammed like in your desktop, laptop, tablet or smartphone?
- What this system needs to do?
- It would be like an open finite reasoning automaton



Classical model of smart systems



Five approaches to reproducing intelligence



- Symbolist approaches:
  - Production rule-based
  - Logical inferencing
- Connectionist approaches:
  - Semantic network-based
  - Artificial neural networks
- Analogist approaches:
  - Case-based reasoning
  - Natural analogy-based
- Probabilistic approaches:
  - Bayesians reasoning
  - Fuzzy reasoning
- Evolutionist approaches:
  - Genetic algorithms
  - Bio-mimicry techniques

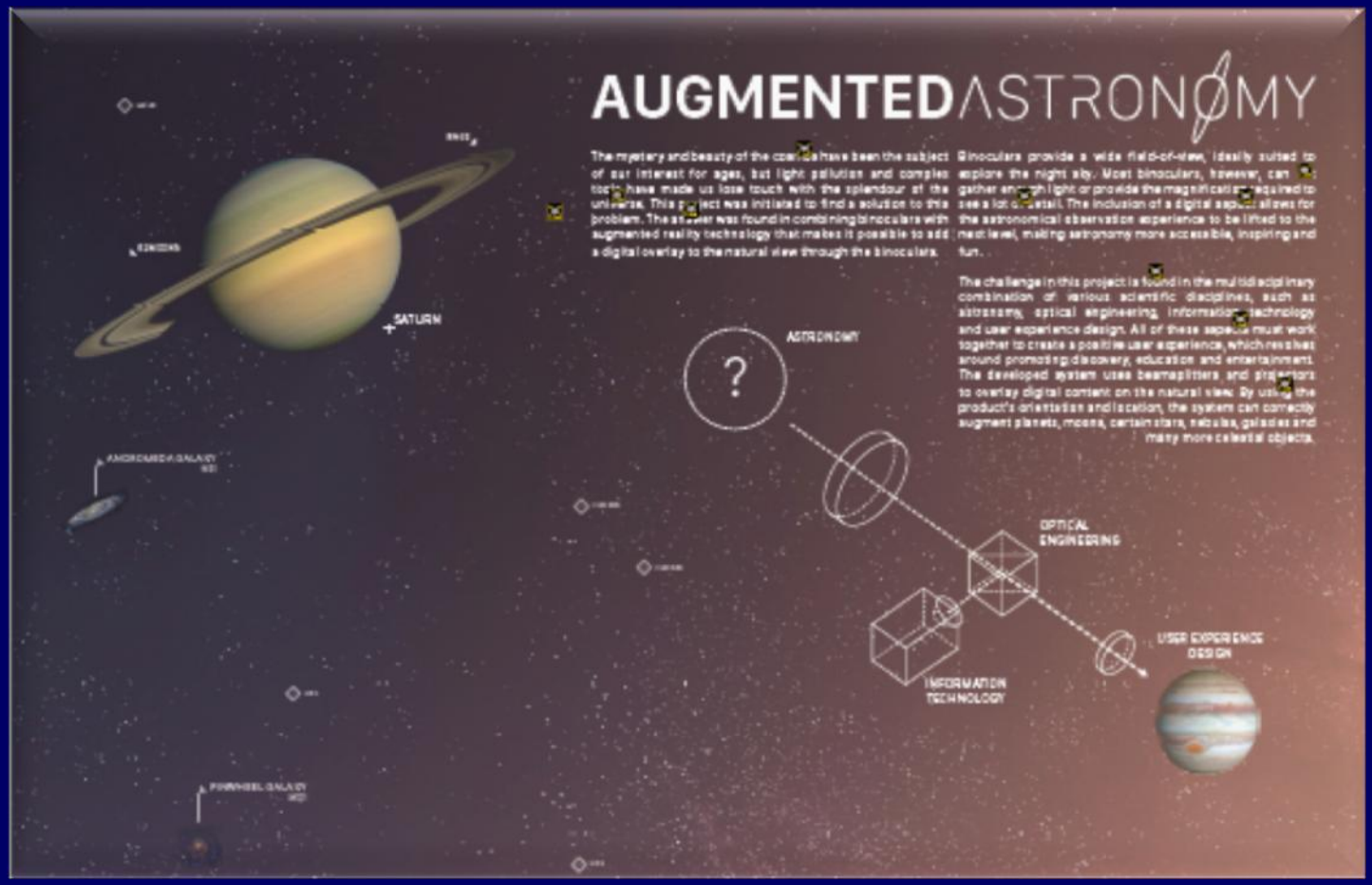
Characteristics of smart products

- Personalization
  Customization according to the needs of the stakeholders
- Awareness
  Consideration of objectives, states, constraints and contexts
- Situatedness
  Recognition of situational and community contexts
- Adaptiveness
  Changing behavior according to objectives and conditions
- Connectedness
  Ability to communicate, integrate, bundle with other products
- Proactivity
  Anticipation of stakeholders' plan and intentions

Source: Modified from Maass, W., and Varshney, U., *Electronic Markets* 18, 211, 2008.

Two representative graduation projects

A cyber-physical educational solution (1)



A cyber-physical educational solution (2)

A cyber-physical measuring solution (1)

A cyber-physical measuring solution (2)

What is the main take away?

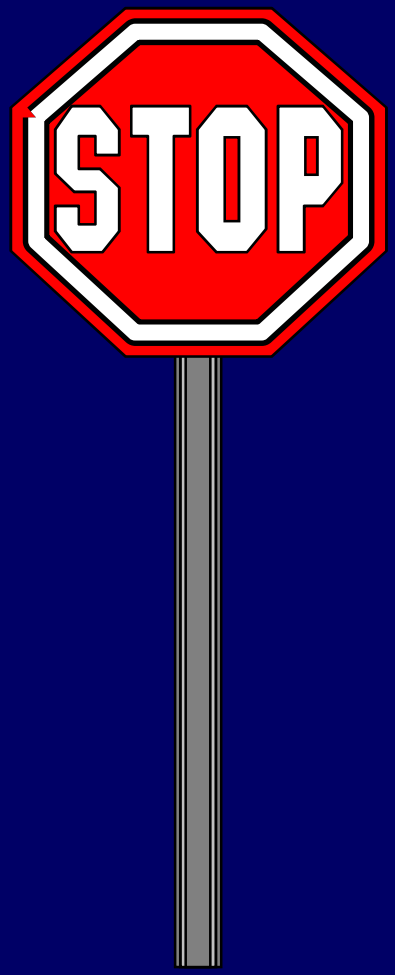
More attention to systems and services

- Everything is becoming a (human-in-the-loop) system and they should be designed skilfully and purposefully
- Future industrial design engineers need to focus on services rather than only on materialized artifacts
- Cyber-physical systems are one important family of engineered systems of high potential future impacts
- Their significance comes from the fact that they can penetrate into real life processes and change them
- They offer new functional opportunities for product/service designers

Novel requirements for the future

After completing your studies you are supposed to be able to:

- monitor human, social, business, technological and industrial trends in a holistic framework
- bring social demands and technological affordances together into triggering relationships
- conceptualize smart artifactual systems and services in various socialized and personalized application contexts
- develop and/or apply purposeful reasoning and learning mechanisms for aware and adaptive systems/services
- apply data analytics and forecasting methods to predict expected behavior, use, misuse of products and services



Thank you
for your kind attention!

Let us now discuss the questions!