A CPS agenda for Europe

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CyPhERS
Cyber-Physical European Roadmap & Strategy

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Cyber-Physical European Roadmap & Strategy

SEVENTH FRAMEWORK PROGRAMME

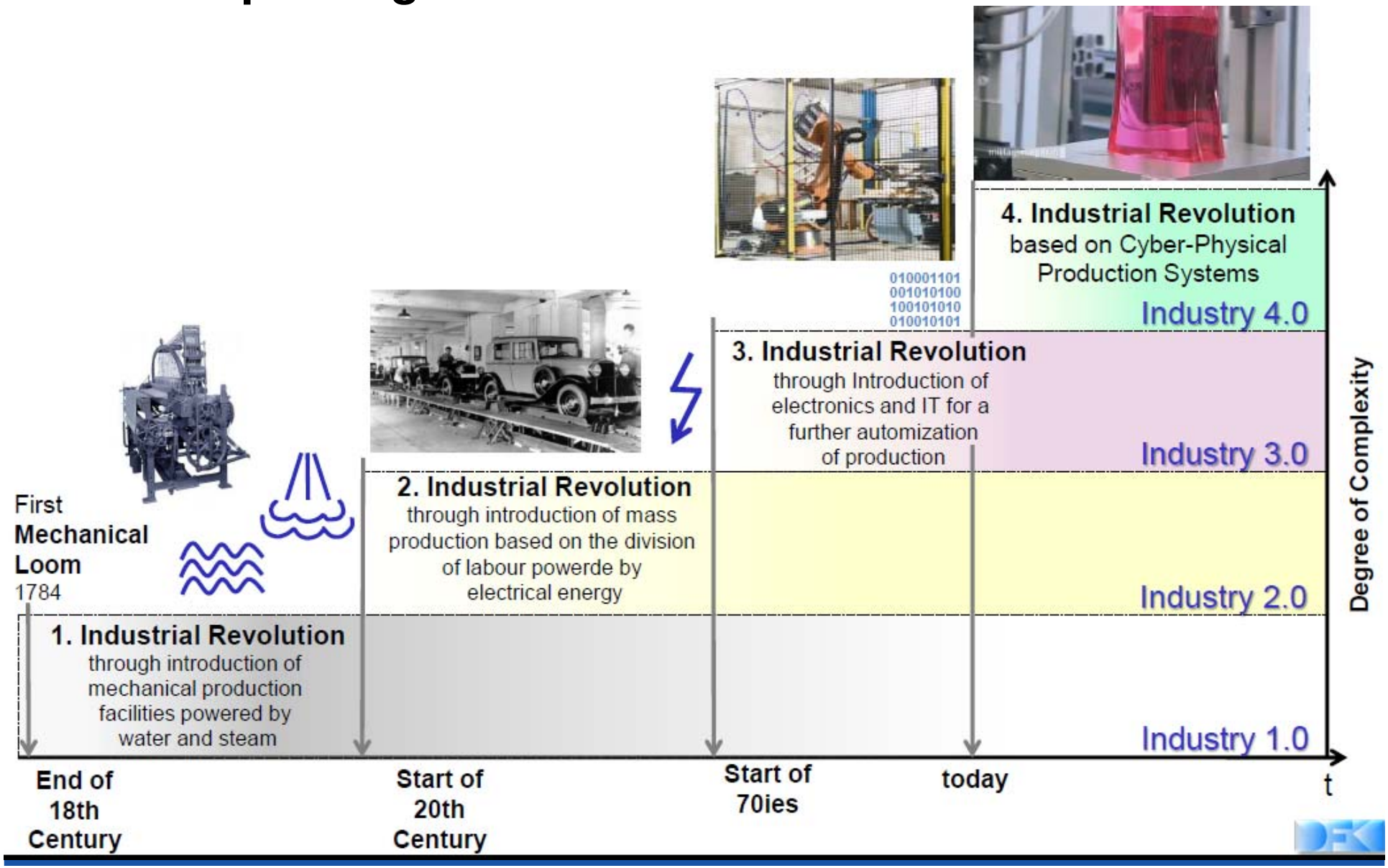
www.cyphers.eu - Fp7 support action, July 2013- Feb. 2015

Purpose: develop a strategic CPS agenda for Europe, including comprehensive recommendations for action

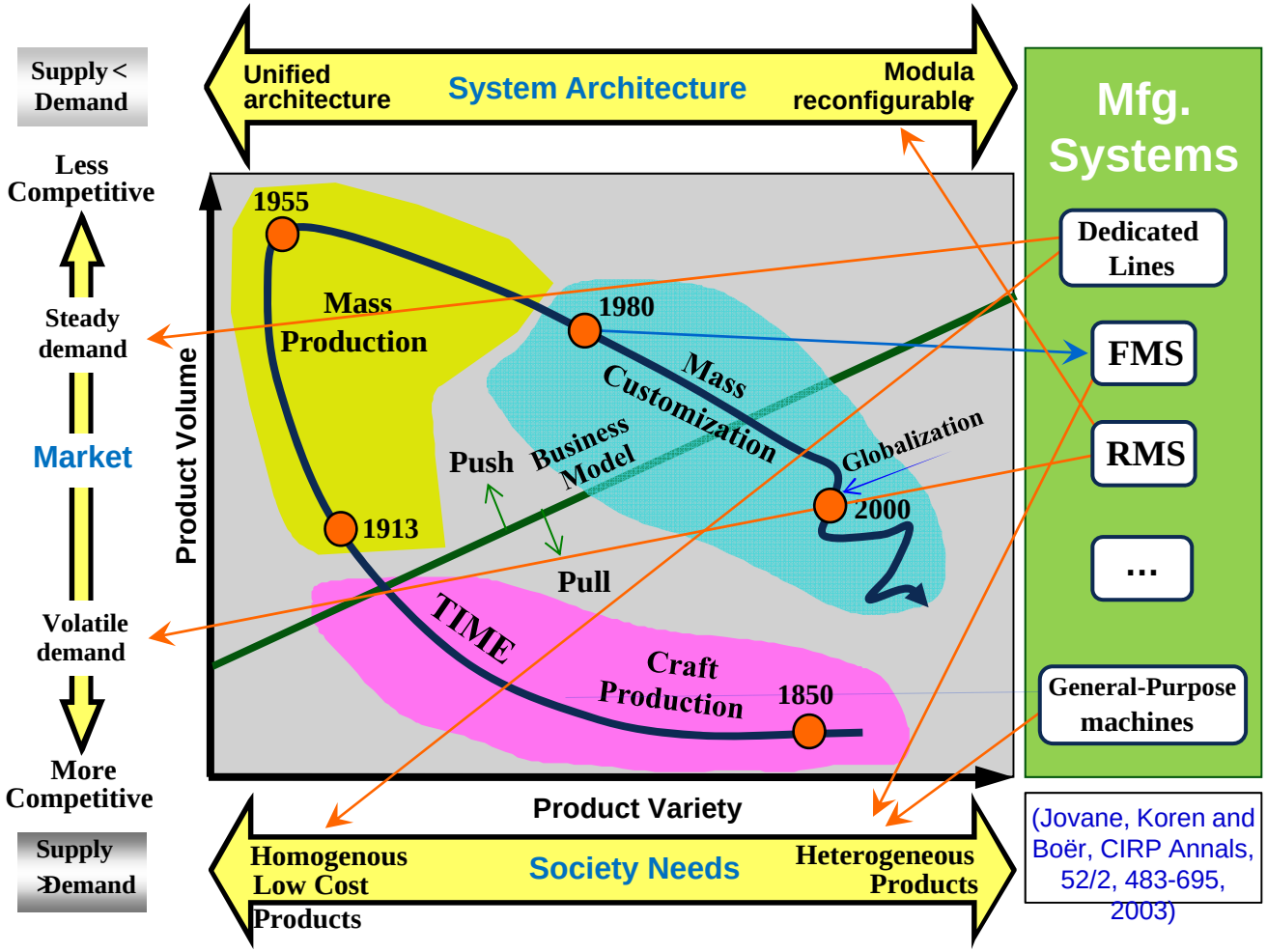
CPS technology, Market model, Domain analysis, … Recommendations

Acknowledgement: This talk reflects collaborative work with
Victoria Cengarle, Holger Pfeiffer, Bernhard Schätz, Fortiss/TUM);
John McDermid (Univ. Of York), Roberto Passerone (Trento);
Saddek Bensalem (Univ. Joseph Fourier) and
Alberto Sangiovanni Vincentelli (Trento/UCB)

Industrie 4.0 – CPS as an organizational paradigm shift



Manufacturing evolution



Current Focus:

- Cloud manufacturing
- Human-robot collaboration
- Programming-free machine control
- Additive manufacturing
- Sustainable manufacturing

Courtesy of Lihui Wang, KTH

Indication of a paradigm shift – new players

CNET › Internet › Google closes $3.2 billion purchase of Nest

Google closes $3.2 billion purchase of Nest

The acquisition brings with it the Learning Thermostat and the Protect smoke and CO detector as Google looks to make its mark in the smart home.

by Lance Whitney @lancewhit / February 12, 2014 5:00 AM PST / Updated: February 12, 2014 5:19 AM PST

theguardian | TheObserver

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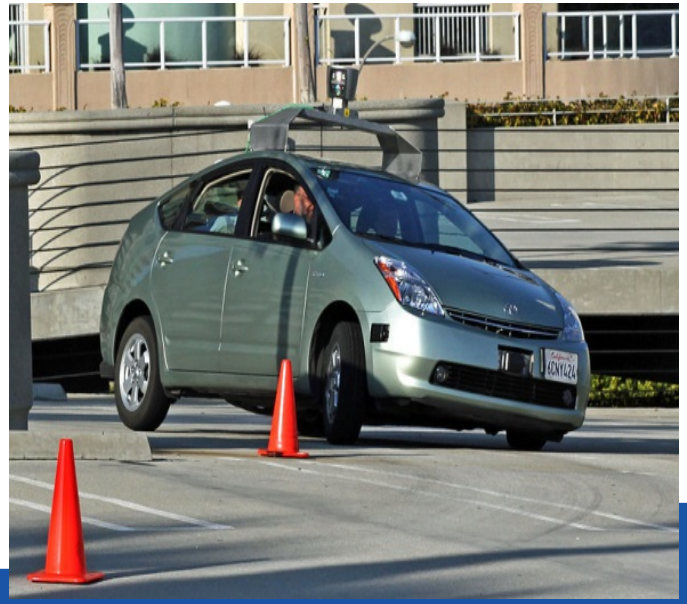
Google's drive into robotics should concern us all

The company's expansion into robotics was developed in tandem with the US military. Where will its power play stop?

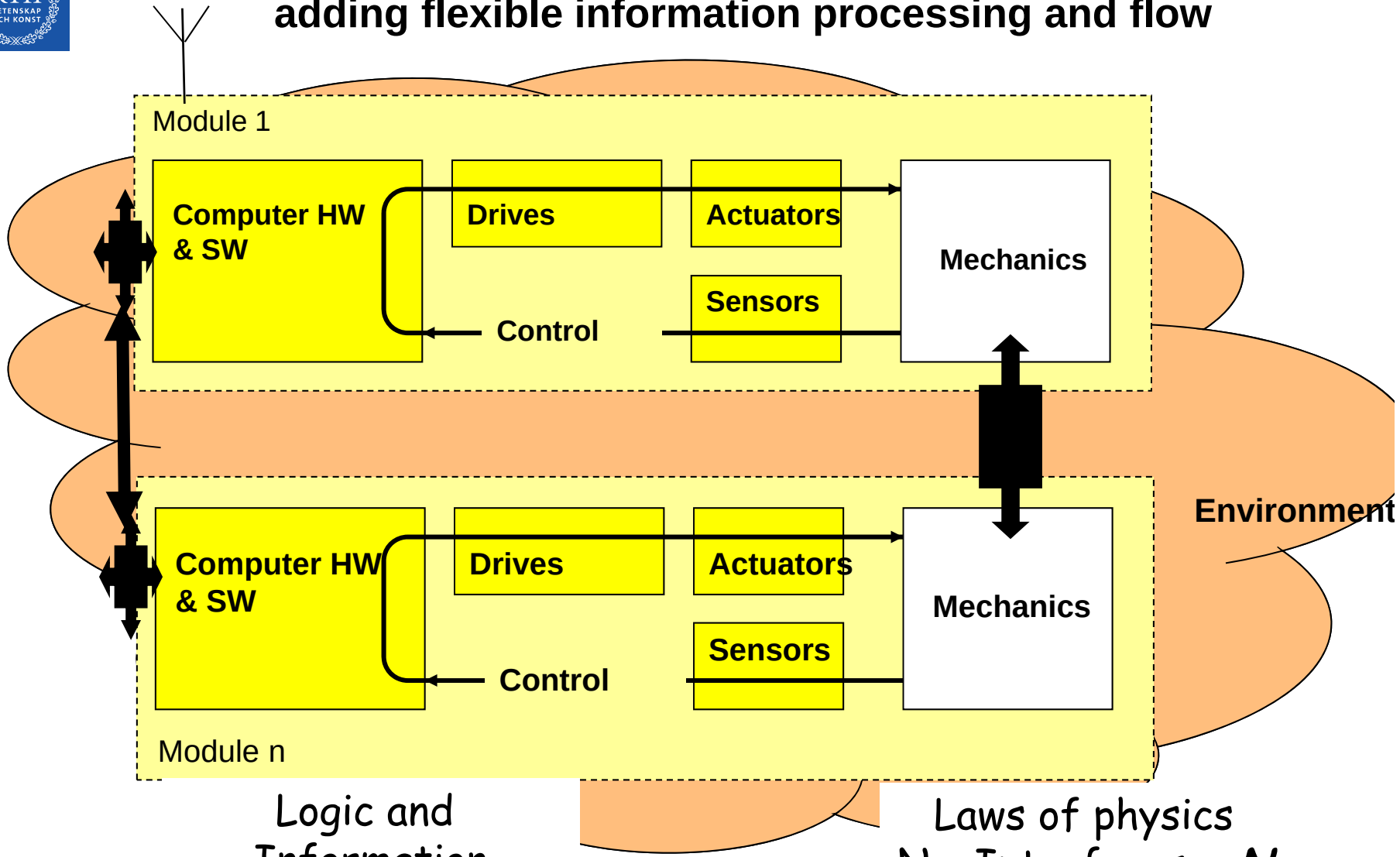
John Naughton
The Observer, Sunday 29 December 2013



Google's robotic cars have about $150,000 in equipment including a $70,000 LIDAR (laser radar) system. The range finder mounted on the top is a Velodyne 64-beam laser. This laser allows the vehicle to generate a detailed 3D map of its environment. The car then takes these generated maps and combines them with high-resolution maps of the world, producing different types of data models that allow it to drive itself.

Mechanics vs. Mechatronics;

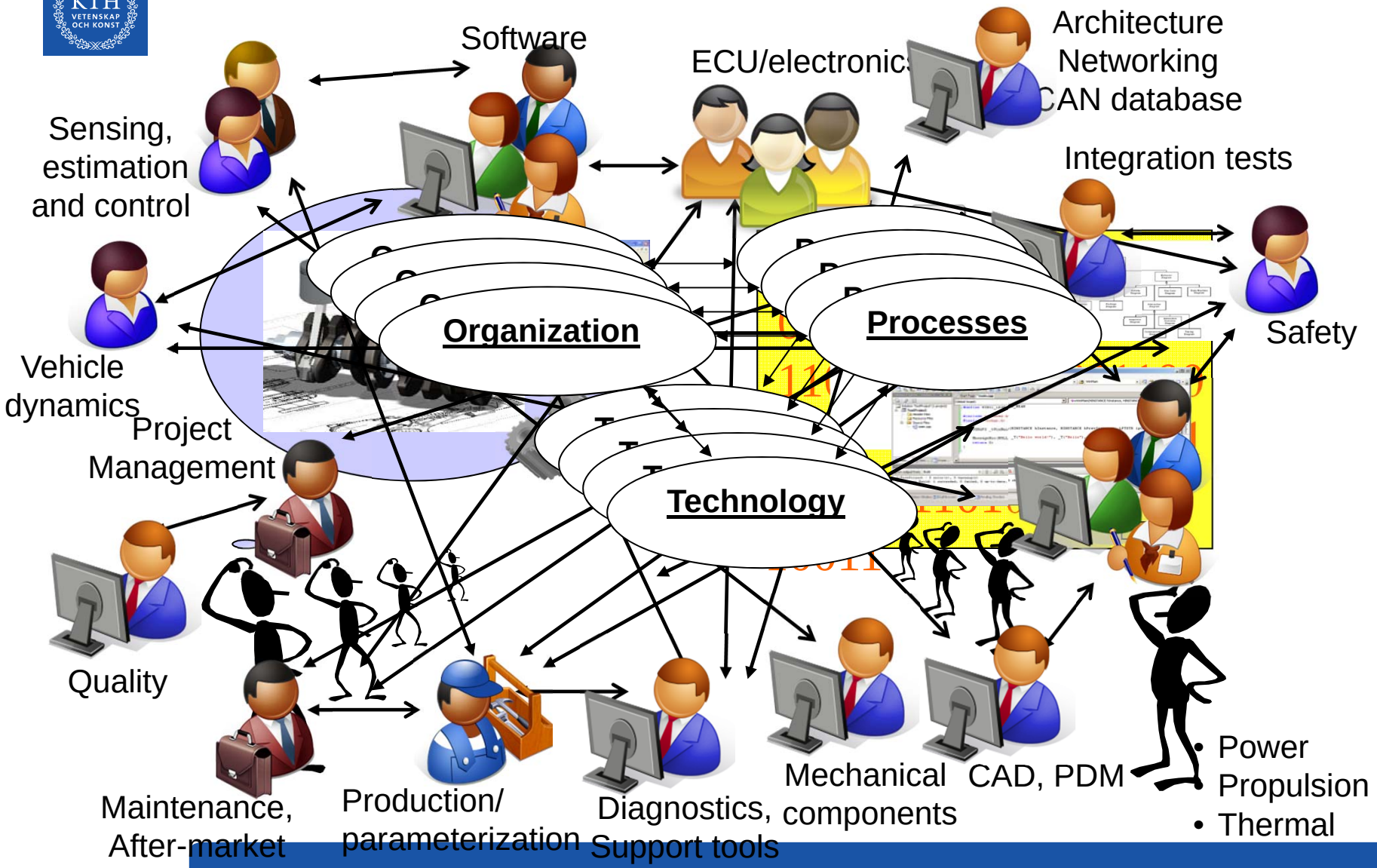
adding flexible information processing and flow



Logic and Information
No. Interfaces >> N^2

Laws of physics
No. Interfaces ~ N

Integration pasta - dependencies



The “Cyber Physical” Gap – Examples

Dimension	„Cyber Domain“	„Physical Domain“
Example Disciplines	Logistics	Aeronautics
Typical Life Cycle	< 2-3 Year	> 10-30 Years
Business Model	Dynamic Value Network	Static Supply Chain
Development Approach	Continuous Delivery	Implement-Commission-Operate –Decommission
Dependability Focus	Security	Safety (and certification)
Platform Approach	Max. virtualization/Cloud	Min. virtualization/RTOS
Example Technologies	Big Data, Online Learning	Control Synthesis

Cyber-physical systems (~2006)

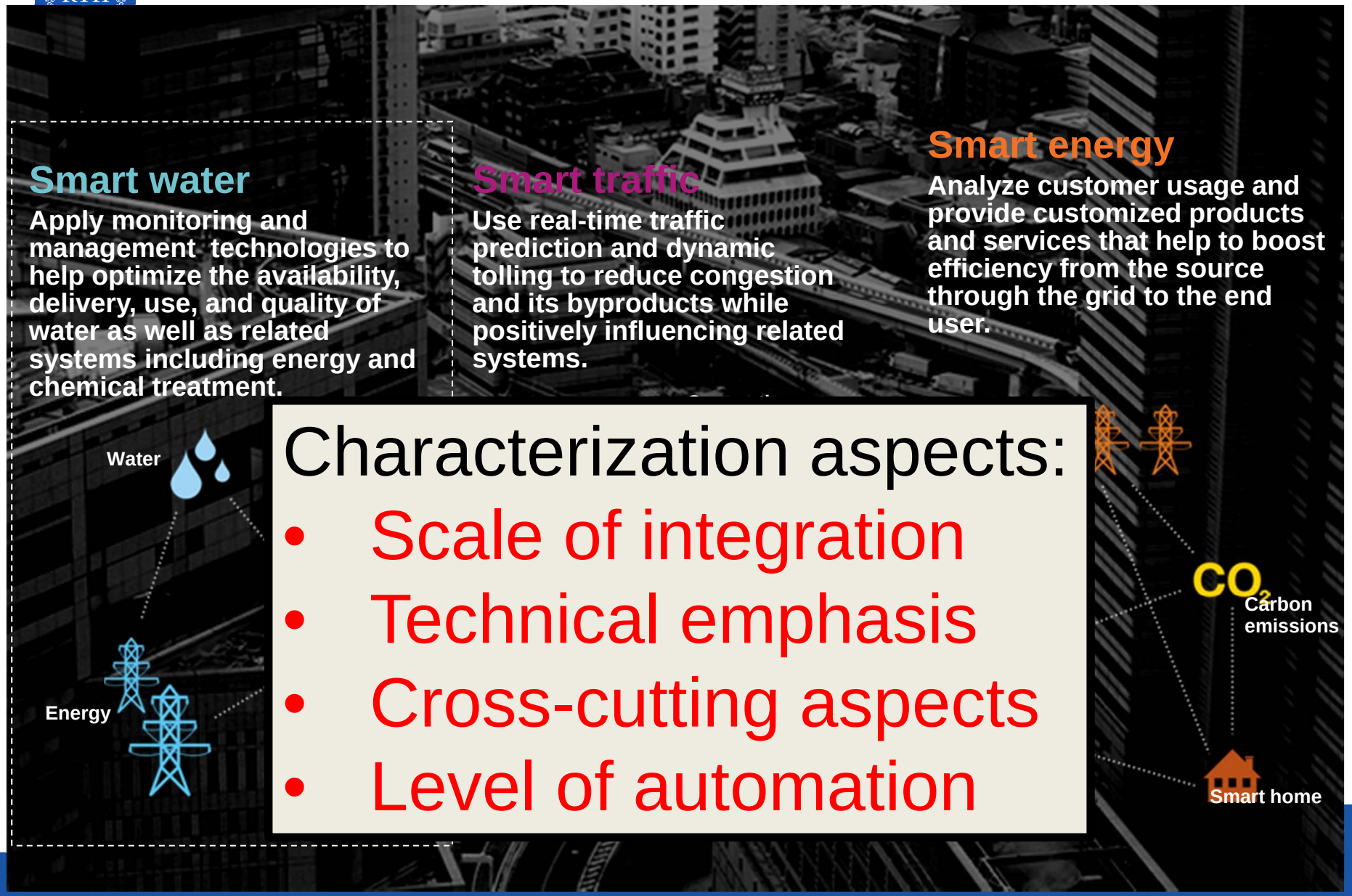
Integration of computation, networking and physical processes where CPS range from minuscule (pace makers) to large-scale (e.g. national power-grid).

Not new but

- Increasing level of integration and capabilities
  - Physical – Embedded – Networking - IT
- Confluence: Consumer products ⇔ Industrial products
- Business model evolution; servitization

Unprecedented opportunities and societal reliance

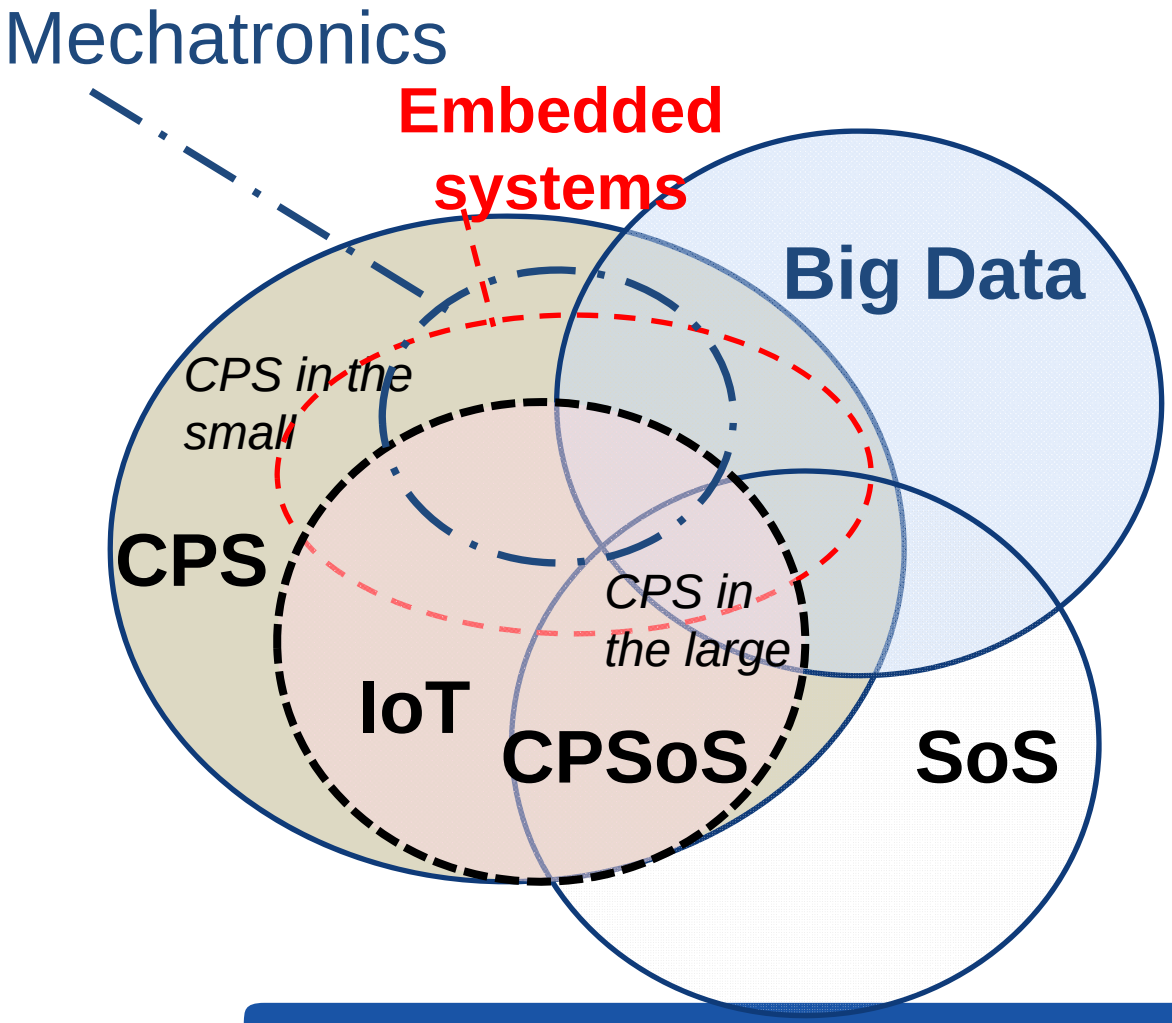
CPS will change the way entire industries operate



Characterization aspects:

- Scale of integration
- Technical emphasis
- Cross-cutting aspects
- Level of automation

CPS and relation to other concepts



Different perspectives!!

Set sizes are not representative

Building systems out of the underlying technologies!

Trend of increasing overlap!

CyPhERS recommended focus areas

- Multidisciplinary research
- Accelerate technology maturation
- Interoperability of technology
- Education and life-long learning
- Business models and open innovation
- Raise societal awareness
- Trustworthiness

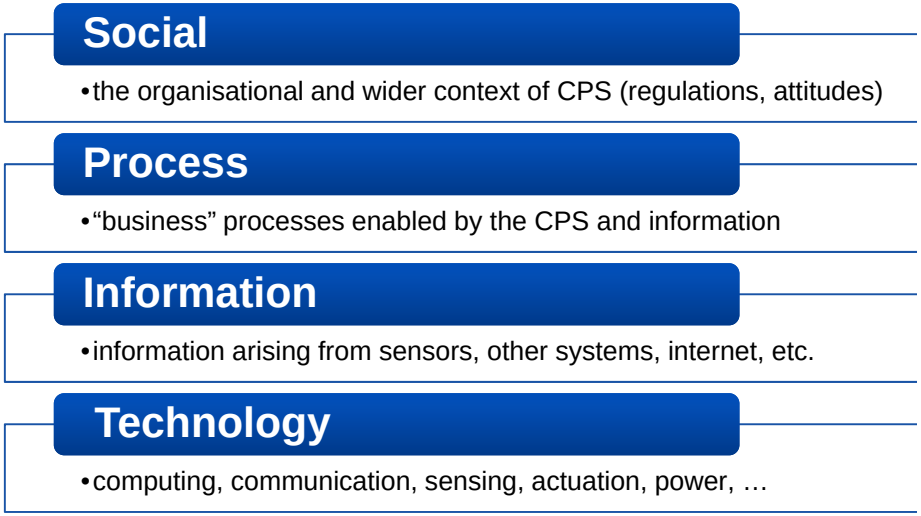
The above include legislation and liability

Science and technology (example highlights)

- Enabling sciences!
- Strengthen cross-disciplinary interactions
  - Human-machine interaction: behavioral science and technical disciplines – from ergonomics to modeling human behavior
- System level design methodologies with supporting platforms
  - Correct by construction
  - Systematic and efficient V&V
- Interoperability standards (horizontal, cross-domain)

Market aspects

- Open Innovation
  - Need collaboration!!!
  - Open standards, Open data, Open source/license
- Servitization: Anticipation of business models addressing value-added services besides tangible assets.
  - Liability frameworks
  - Forums and eco-systems



CPS education and training (highlights)

Paradigm shift motivates extra efforts for revising programs

- Increasing space of knowledge and skills!

Balances and the concept of synergy:

- Depth vs. Breadth, Theory-Practice-Com. skills
- Academia and industrial collaboration

Life-long learning

Sustainability, privacy and ethics

Improving the status of teaching

From disciplinary to ”Pi-shaped” people that are ready to engineer!

Find a suitable balancing – for the T-shape - depth vs. breadth,

Teach experts, with various expertise, able to synergistically work with other experts.

CPS characterization - summary

- Scale of integration and emphasis
  - Physical, embedded, networking and IT systems
  - Life-cycle, Domains
- Cross cutting aspects: properties, jurisdiction, governance
- Level of automation
- CPS, IoT, Industrial Internet, Industrie 4.0 etc. - different perspectives to integration and software intensive systems
- An ”organizational” paradigm shift

Technological **Organizational/Business** **Societal**

Push

Software
Networking
Wireless com.
Sensors and actuators
Packaging/integration
Computing technology
Software platforms
Control methods
Tools
...

Properties
Performance
Dependability
Risks & costs!
Trade-offs

Science and Technology

Design
Behavior
Architecture
Information

Society
Legislation; standards
Education, debate!
Sustainability

Organization/Business
Management
Organization
Open innovation

Pull

Energy

Transportation

Healthcare

Competitive production

Comfort

Entertainment

Key messages

Cyber-Physical Systems (CPS)

- Integrate physical, embedded, networking and IT systems
- Bridge disciplines, domains & life-cycles

CPS, IoT, Industrial Internet, Industrie 4.0 etc.

- Provide different perspectives to similar phenomena
- Characterization helps to clarify system of interest

CPS are sociotechnical systems

- Unprecedented opportunities for innovation
- Disruptive changes in both economical and societal sense
- Corresponding challenges, barriers and threats
  - Education, Research and Collaboration

See CyPhERS agenda here: www.cyphers.eu