PLATFORMS 4CPS

Platforms4CPS, a coordination and support action in the area of Smart Cyber-Physical Systems.

Some highlights and snapshots on activities

Follow Platforms4CPS:

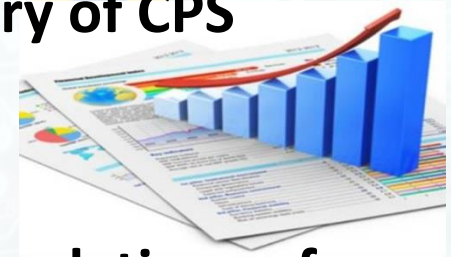
Charles Robinson
22/06/2017
IEEE – 13th System of Systems Engineering Conference

Platforms4CPS - Vision

Creating the CPS Vision, Strategy, Technology Building Blocks and Supporting Ecosystem for Future CPS Platforms by

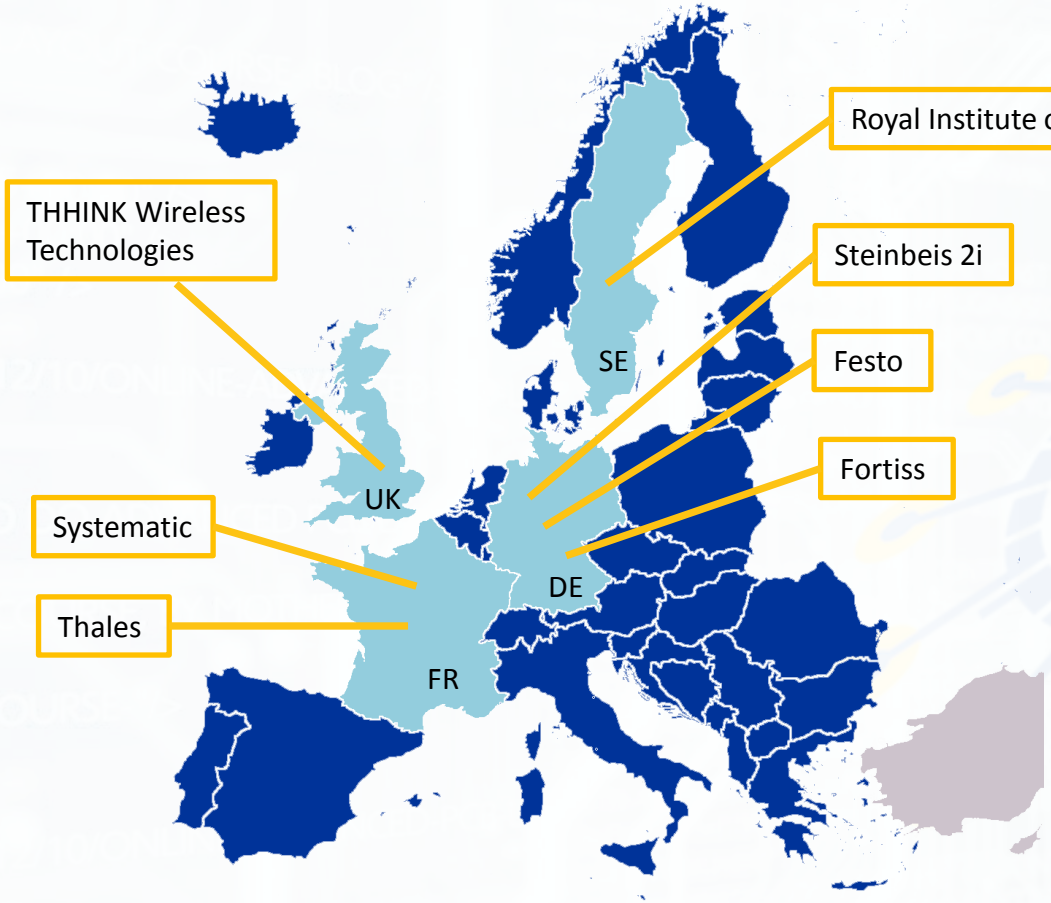
- Analysing the ecosystem and **market perspective** and strategically updating and validating existing **CPS roadmaps**

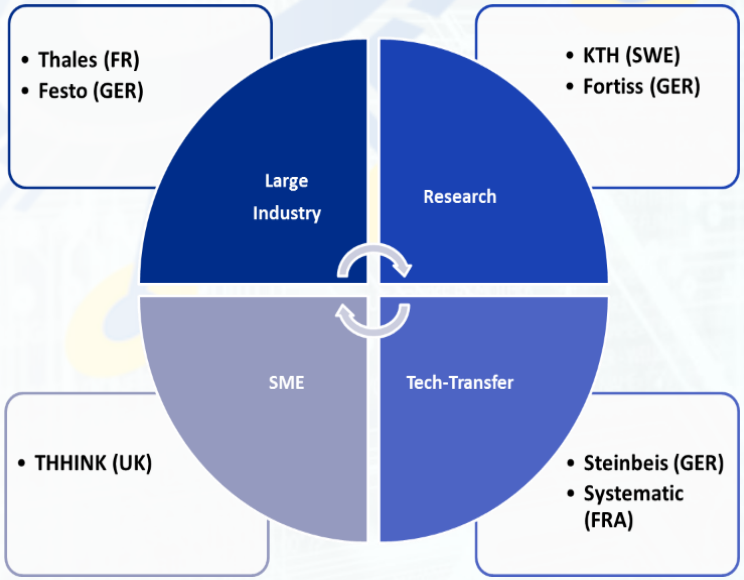
- Promote **platform building** and create a **repository of CPS technology building blocks**



- **Build up an ecosystem** by **cooperating** on the **foundations of CPS engineering**, and supporting **consensus-building**

Platforms4CPS Consortium

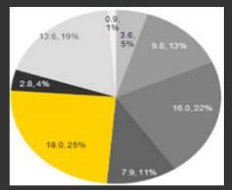




Platforms4CPS - Approach

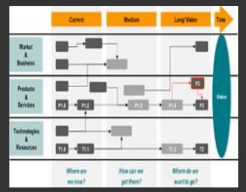
Approach

CPS, Industrial IoT Landscape



- Worldwide market segmentation
- Validation workshops
- Opportunities for European ecosystem of technology providers
- Recommendations for business opportunities

Roadmapping Recommendations



- Roadmapping methodology
- Mapping CPS roadmaps
- Roadmapping consensus workshops
- Updating and validating CPS roadmaps
- Recommendations for research and innovation priorities

Platforms Pre-normative Activities

- Analysis of CPS technology platforms
- Platform arena
- PlatForum
- Repository of building blocks
- Demand side elicitation of needs

Constituency Building Collaboration

- Foresight community and building up the ecosystem
- Collaboration with other EU programmes
- Collaboration on foundations of CPS
- Consensus building, raising awareness

Dissemination Exploitation

- Corporate ID, website and social media
- Publications, fairs and conferences
- EU-consultation meeting
- Dissemination and exploitation plan
- Strategy to sustain Platforms4CPS

Project website – Interesting Studies and Slides of Workshops

Deliverable 1.1_Market segmentation for CPS technology

Deliverable 1.2_European ecosystem and market opportunities assessment

Deliverable 3.1_Analysis CPS platforms

Deliverable 3.3_PlatForum Report

Deliverable 3.4_CPS Platform Building Blocks

Deliverable 4.1_Foresight Community and Ecosystem Report

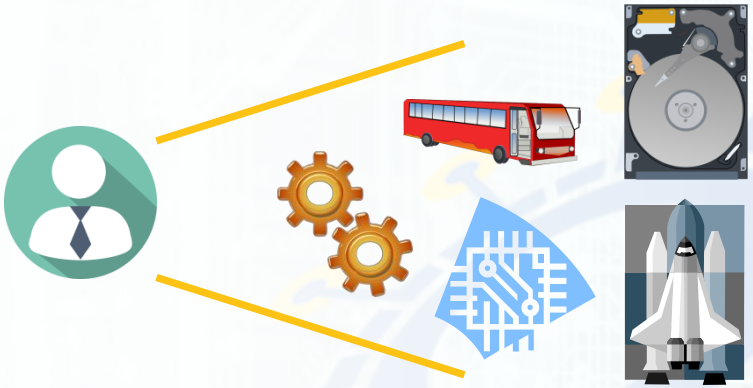
Deliverable 4.3_Collaboration on the foundations of CPS Engineering

CPS & Industrial IoT Landscape

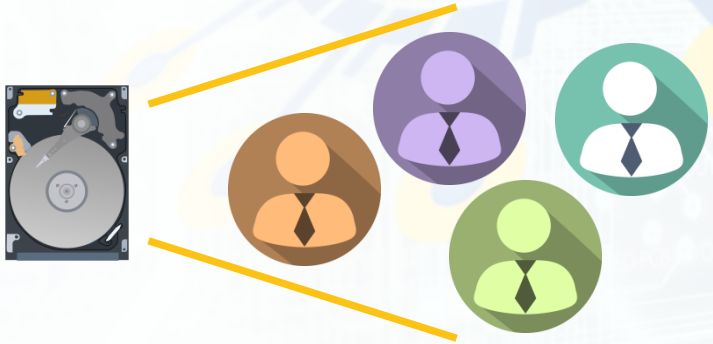
Highlights relating market analysis & segmentation, competition, European ecosystem

Market Analysis (Survey & Segmentation)

Market Survey – Client perspective categorising technologies



Market Segmentation – Technology perspective categorising clients



Market Survey

- In domains of **transport, health, manufacturing and energy**.
- Classification of CPS in existing market studies found often to be very generalised including partial CPS (such as only monitoring).

- **Manufacturing** represents **about 80% of European exports** - **Interoperability and common standards** key roadblock for I4.0 implementation. Over 100 standardisation organisations worldwide - risk of local standards is high, resulting in risk of technological lock-in.

- **European medical technology** estimated to be **31 % of the world market**. Second largest after the US (40%). **Highly innovative** industry (R&D investments up to 12 % of revenues) with **80 % SMEs**.
  - Highly fragmented.
  - A global viewpoint can be misleading because **market highly dependent on country**
  - **Very high long-term care expenditure disparities** across EU countries (differences seem as much as 1 to 1000).

Market Survey

- **European Transportation**
  - **Automotive 4%** of the EU's GDP and largest private investor in R&D.
  - **Rail accounts for nearly half of the world market** and a total production value of €40 billion (2010). Research activities highly fragmented – EC and industry initiative to bring them under one roof (Shift2Rail)
  - **Aerospace** turnover of €140 billion in 2013. **50 million passengers a year - expected to double in next 20 years**. Challenges include safely accommodating this increased use of aerospace whilst protecting the environment.
  - **Shipping is 90% of world trade** – 3 of the top 5 ports are European and ~40% of merchant fleet controlled by European companies.

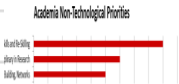
- **Energy** - For **six years in a row the renewables sector has outpaced the fossil fuels sector for investment in power capacity additions**. Wind and solar PV account for about 77% of new installations, with hydropower representing most of the remainder. **China accounts for about half of this.**

- Very extensive review of the market figures for CPS domain on our website.

European ecosystem and market opportunities assessment

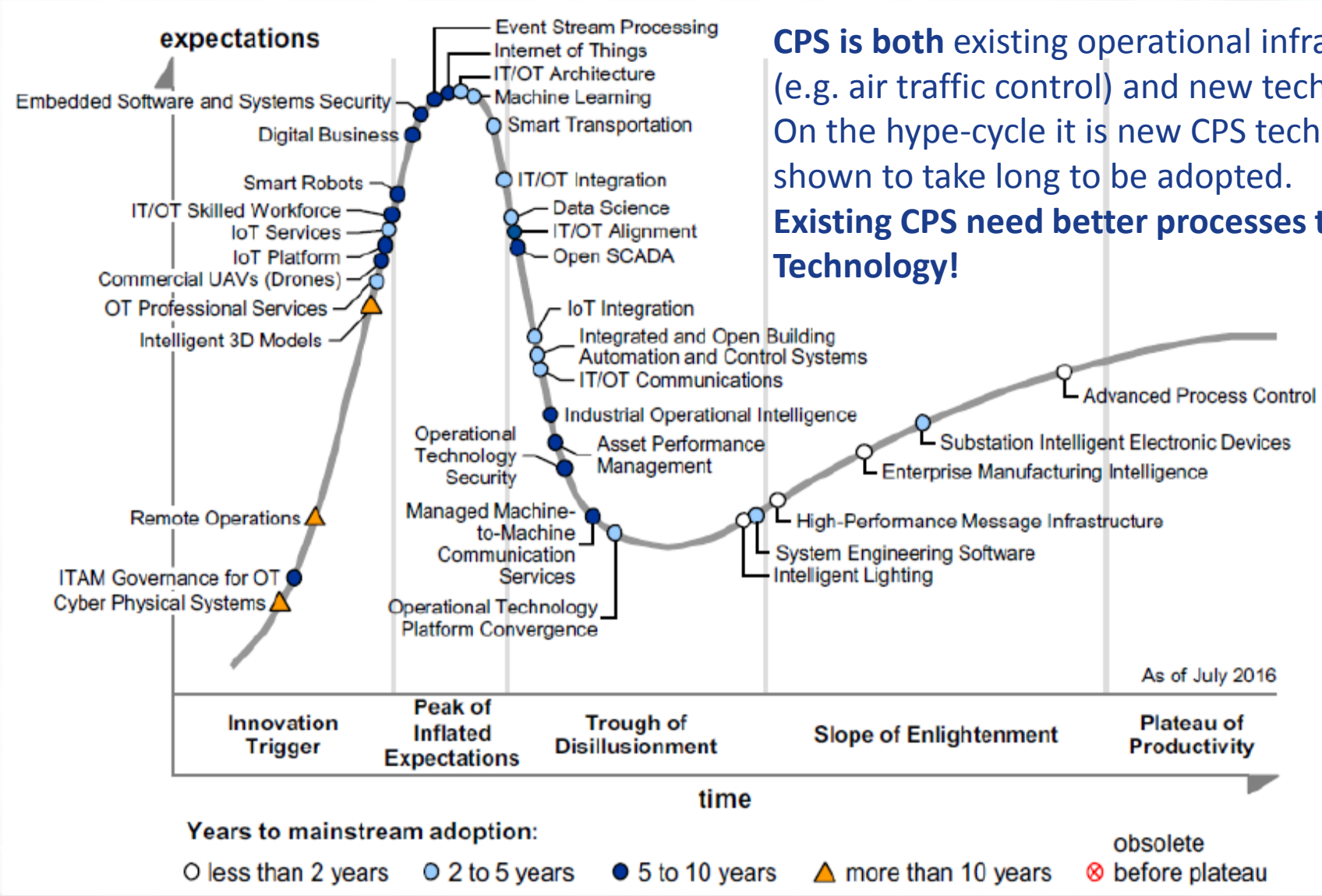
- See technical brief (15 pages) or full comprehensive study (97pages).

CPS ranking from various stakeholders & linked with roadmapping activities



LI, SME & Acad	Cyber/Security, Privacy, Confidentiality, Trust Integration, Interoperability, Standards AI, Cognitive Systems, Autonomous Systems
LI	CPS Engineering (Requirements, Design, Testing)
LI & Acad	Safety, Reliability, Resilience, Fault Tolerance Modelling and Simulation (Virtualisation)
LI & SME	(Big) Data, Real Time Analysis, Visualisation
SME & Acad	Platforms, Reference Architectures, Tools Humans in the Loop Situational Awareness, Diagnostics, Prognostics, Decision Making and Support
SME	Human Machine Interface (HMI)

Hype-cycle for operational technology (Gartner 2016)



CPS is both existing operational infrastructure (e.g. air traffic control) and new technologies. On the hype-cycle it is new CPS technology shown to take long to be adopted.

Existing CPS need better processes to adopt Technology!

CPS Market Segmentation

- Launch of the first public study for CPS.
- **Important factor for tailoring technology** to meet needs for the most relevant customers. Enables **analysis** of customer **profitability** and where to compete. Can show hurdles to be solved and reveal new customers.

- Help build the knowledge base via https://platforum.proj.kth.se

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CPS Market Segmentation

Market Segmentation is an area where public shared knowledge is sparse, but is believed will bring value to the CPS community through contributions towards expanding such a knowledge base. Identifying segments is frequently an important factor for tailoring technology to meet needs that will be desirable for the most relevant customers. This technique enables an analysis of customer profitability and where to compete, it also can show hurdles to be solved and reveals customers previously unrecognised.

and cons | Votes

rgument | 0 Vote

Large Enterprise
by Charles Robinson (Thales)
Often LEs state product reliability as a key purchasing factor, but a recent survey derived that ... more
Add argument | 0 Vote

Selling in Europe
by Charles Robinson (Thales)
Buyers generally expect to meet face to face.
-Influenced more by seeing metrics than visions of... more
Add argument | 0 Vote

Selling in the United States
by Charles Robinson (Thales)
-Buyers are tending more towards online purchasing, with engagement analytics used to understand ... more
Add argument | 0 Vote

Selling to the Civil Sector
Add argument

CPS Roadmapping and Recommendations

Highlights relating mapping roadmaps strategic updates and validation

Methodology

- Following the objective to strategically update, validate and harmonise existing CPS roadmaps, activities focussed on:
- **Mapping** the national, European and international CPS/IoT roadmaps
- **Identifying and discussing** CPS concepts, research challenges, enabling technologies and barriers.
- **Holding a series of 'Roadmapping Consensus Workshops',** with community representatives.
- **Evaluating priorities & defining strategies** to address the major enablers and barriers for successful CPS deployment.
- **Creating a 'living' roadmap document,** the 'Community Roadmap' on the Platforms4CPS website
- **Encompassing the views** and initiating discussion **amongst key stakeholders** as well as the development of the ecosystem

Innovation Accelerators

- **Collaboration** across initiatives, international collaboration
- Access of **SMEs, start-ups and scale-ups** to the eco-system
- **Openness**, open data, open innovation, open platforms
- Demonstration, **pilot lines** and living labs
- **Business models,** servitisation, data driven economy, crowd funding, blockchain
- CPS standardization, **regulation**, liability, **privacy** and **ethics**
- T-shape, cross-disciplinary **education**, life-long learning, (re/up-)skilling, avoid **digital divide**
- Raise **awareness**, promote societal dialogue, enhance user acceptance & trust
- **Discuss risks** like **IT addicts**, vulnerability, digitization changes our behaviour and even **brains**
- Create a **positive vision** and respective plan for CPS developments and implementation

Roadmapping CPS technology focus themes (snap shot)

The "**CPS platforms & interoperability**" group revealed the following priorities and recommendations:

- From a fragmented landscape towards composable, open, cheap plug-and-play components
- Federation/orchestration of increasingly decentralized, more dynamic platforms
- From (cloud) centralized AI to AI at the edge, neuromorphic processors, quantum processors
- Towards selling experiences on trusted CPS market-places within the business eco-system

The "**CPS engineering**" group raised the following priorities and recommendations:

- Managing composability with systems of agile/intelligent CPS devices (design time > runtime)
- Enabling technologies, methods, design tools from multiple disciplines including AI
- Engineering methods and design tools for highly-dynamic systems of CPS in uncertain contexts

Roadmapping CPS technology focus themes (snap shot)

- Within the group work "**Autonomous CPS**" the following priorities and recommendations were raised:
- From self-healing, self-learning to self-reconfiguration and full-autonomous decision making
- From machine learning, pattern-recognition, and data-fusion towards algorithms to extract filtered information and miniaturized energy efficient data centres
- Increasing integration of co-bots and user interface adaptability towards AI enabled assistants
- Ensure trust and take ethics into account

- The group on **"CPS safety, security, trustworthiness and compliance"** pointed out priorities regarding:
- Frameworks for legislation, certification, trustworthiness and cybersecurity
- Safety, security, privacy and transparency by design and co-engineered
- Really secure solution for biometrics and forensic
- Push research at the intersection of AI and cybersecurity

CPS Platforms and Pre-normative Activities

Highlights relating analysis of existing technology platforms, PlatformArenas, PlatForum, Builiding Blocks Repository

Survey of Platforms (In our context – A platform aids integration or distribution of technology)

- **83 platforms** analysed **15** different platform types could be **categorised** based on specific challenges during the development or "life-cycle" stage of a CPS.

- Platforms from the **US** are **mainly technical and more cross-cutting and commercially-/market oriented.**

- **More European platforms** of an **organisational type**, but useful as seedbeds for technical and operational CPS initiatives. **Technical platforms** seen to have **more problem- or domain-specific** focus

- **European platforms more open** than US platforms

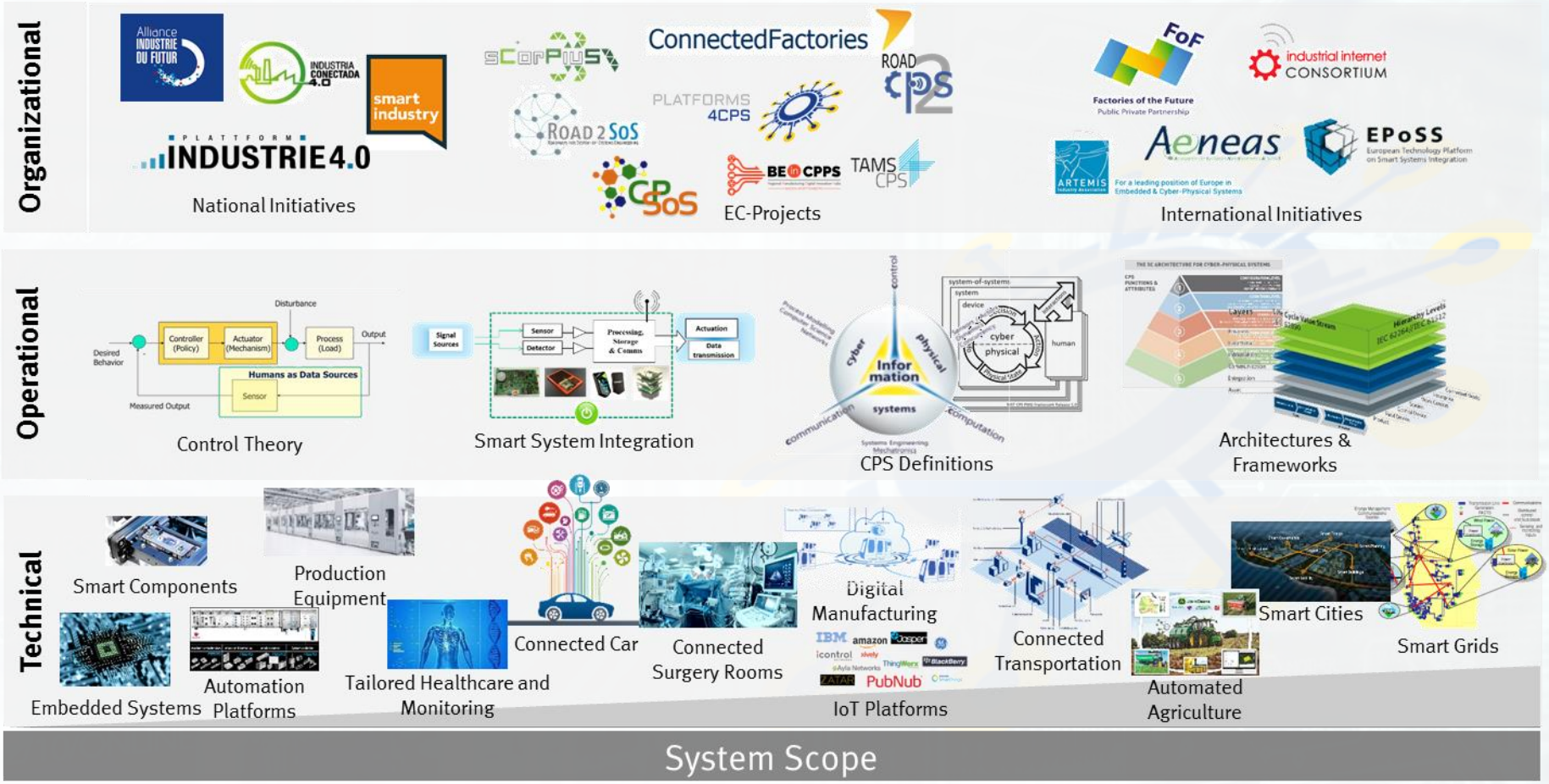
- **Connectivity a major factor so IoT plays significant role here**.

General note: Google searches show ~ x100 more pages related to IoT than CPS

- One reason is CPS is between business rather consumer.
- CPS industry should increase public visibility

Interesting point: You can bring IoT to CPS but is the reverse equally true?

Some of the Platforms Analysed



- More generally, for the **Medical Domain** there seems to be **no platforms of full CPS** at Operational/Technical levels.

Interacting on the PlatForum

- Contribute to **CPS eco-system building**: Platforum gathers academia & industry in a virtual community
- **PlatForum** is an on-line web-site for stimulating debate
  - wiki, blogs, questionnaires, and discussion forums
  - specific entries for Platforms4CPS key tasks, e.g. **Foundations, roadmapping, repository of building blocks**

PLATFORMS 4CPS

Platforum

Welcome to the PlatForum by Platforms4CPS

Platforms4CPS (full title: Creating the Cyber-Physical Systems (CPS) Vision, Strategy, Technology Building Blocks and Sup
'Coordination and Support' action in the area of Smart Cyber-Physical Systems which was officially launched in November 20

The project aims are to implement strategic actions for future CPS through roadmaps, impact multiplications and constituen
CPS. The Platforms4CPS project is coordinated by Thales SA and implemented by 7 partners from 4 European countries (Fran

This site, the **PlatForum**, was created by Platforms4CPS as a forum for information exchange and identification of best practi
and academic developers.

The PlatForum has a public part, which includes expert-driven blogs and dissemination of results from workshops. There are

1. Industry 4.0
2. Context, Foundations and Impact of Cyber-Physical Systems
3. Intelligent Transport Systems (ITS)

If you want to comment on these blogs, please contact us to request a login to the PlatForum first. Thanks.

The PlatForum also has a private part, which includes community-driven forums.

To take part in the latter please contact us for more information.

Log in

PLATFORMS 4CPS

Platforum

Foundations of CPS Working Group

Welcome to the Foundations of Cyber-Physical Systems

Please find here the following initial information:

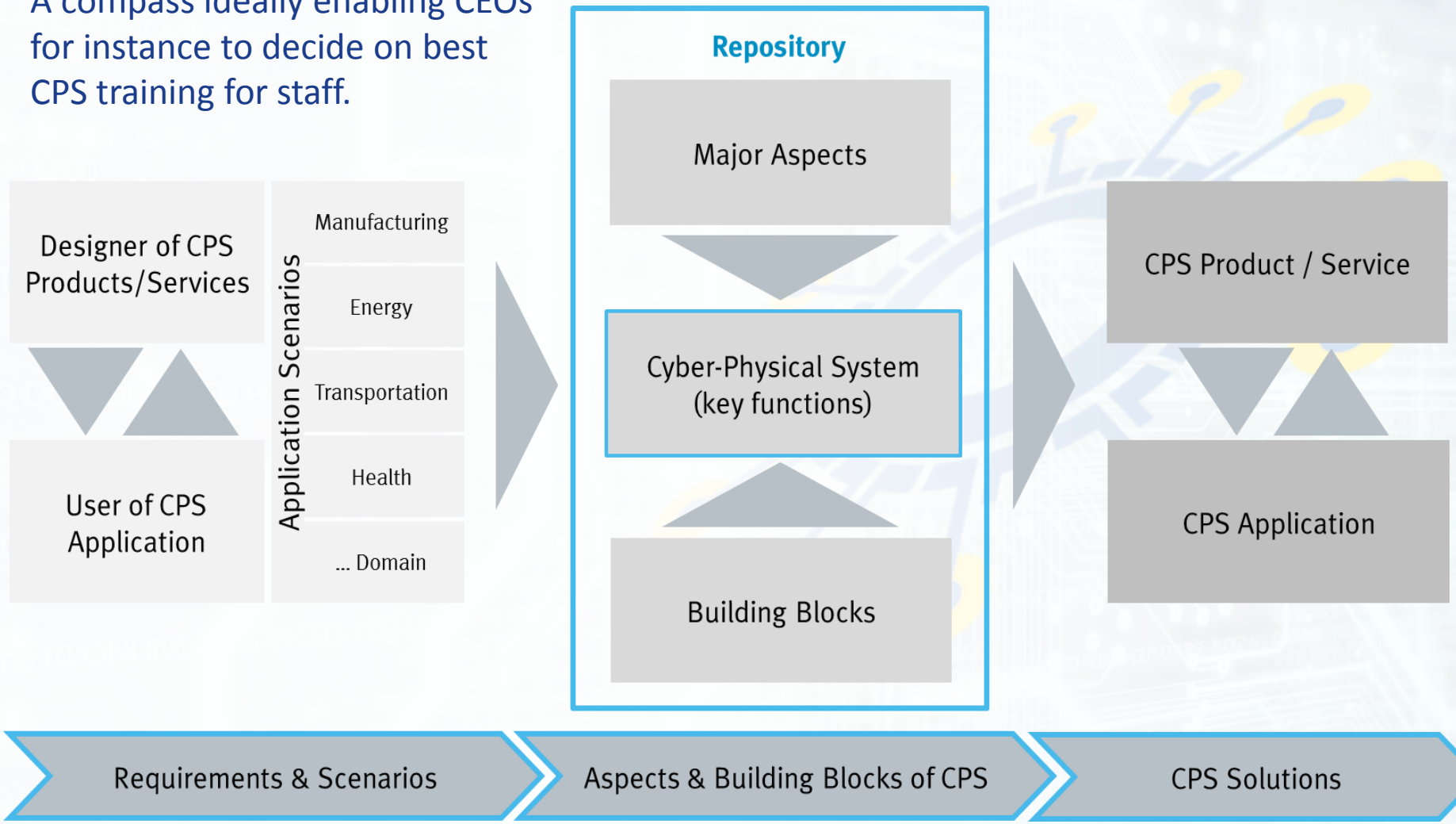
- Blog related to the Foundations of CPS (initiated July 2017)
- Program and information for the CPS foundations workshop in Stockholm June 2nd 2017
- Links to related material on CPS
- Main forum for Foundations of CPS Working Group

Category: Public
wiki page:
HomePageExternal **Foundations of CPS - Related Work** **Foundations of CPS Working Group** **Stockholm Workshop June 2017**

Powered by Tiki Wiki CMS Groupware | Theme: Cosmo

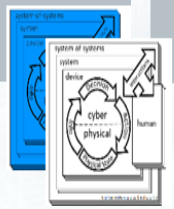
Initiating CPS Building Blocks and a CPS Compass for the Community

A compass ideally enabling CEOs for instance to decide on best CPS training for staff.



Scenarios for Sketching the Scope

High level description of scenarios / Vertical	A Horizontal interconnectedness	B Vertical interconnectedness	C Increased level of servitization	D Specific functionality, limited interconnectedness, lowly digitized environment
Smart Manufacturing	▪ Technology supports the interconnectedness of ecosystem entities ▪ Interconnectedness describes the availability of information in a market to perform a physical action ▪ e.g. release an order, increase stocks, optimize energy distribution, devices provide information of patients to multiple parties,...	▪ Technology supports in optimizing in an organization/entity ▪ E.g. load management for power plant, equipment in hospitals increasingly interconnects to improve effiency,	▪ Technology enables to increase the level of servitization ▪ E.g. energy markets, production services, logistic services,...	▪ Functional scope of solutions and interconnectedness is limited (Cyber Physical Micro Functions/Services/Systems) ▪ limitation die to specific need for application ▪ E.g. autonomous maintenance function, optimized failsafe embedded system for aeronautics,...
Smart Transportation				
Smart Health				
Smart Energy				

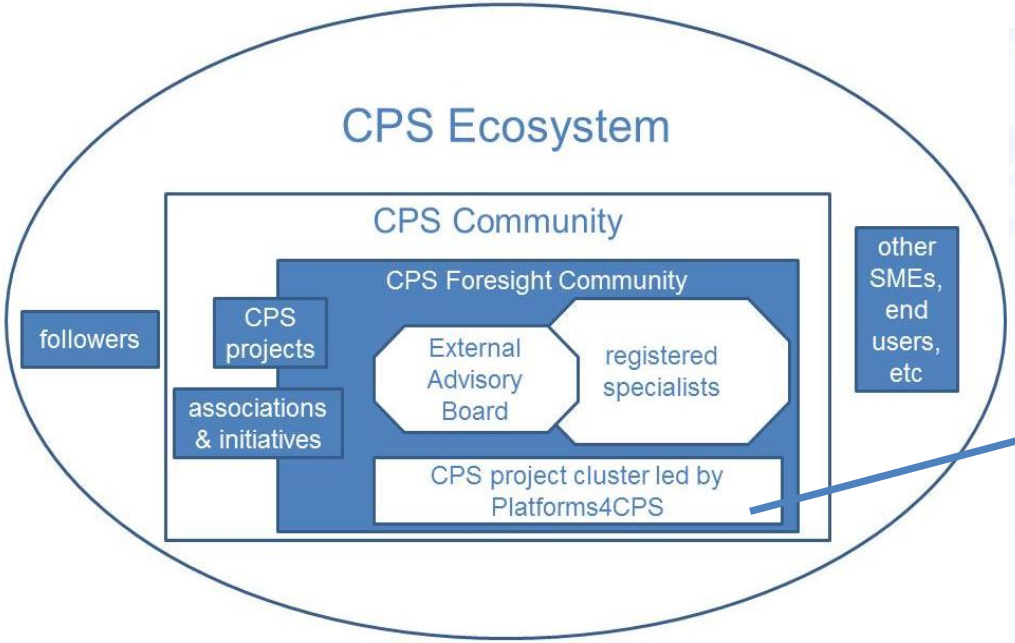


Collaboration building and creation of foresight community

Highlights relating to building up the ecosystem, CPS Foundations, collaboration between projects & European Programmes.

Consensus & dialogue on societal and legal issues.

Building up the Ecosystem



CPS Cluster

PLATFORMS 4CPS

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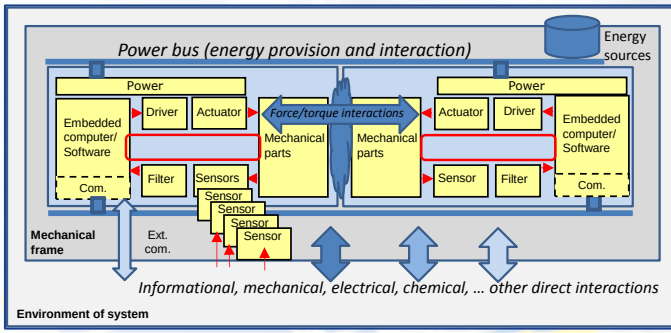
cpswarm

Collaboration Building and Consensus

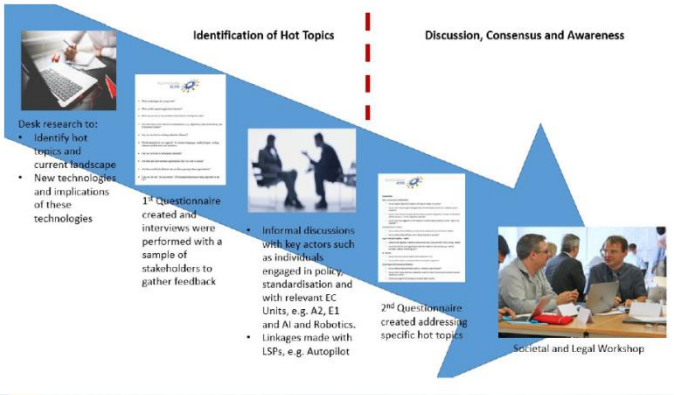
- Workshops to engage the community on vision/roadmapping/foundations
  - CPS Cluster kick-off (+ monthly phone meetings)
  - CPS & IIoT Landscape Workshop
  - Foundations of CPS
  - Four 'Roadmapping Workshops'
  - Four PlatformArenas took place inviting SMEs with respect to discussing Platform access.
  - Collaboration enhancement meeting with European Programmes and Projects.

- **Save the date** (Wednesday 12th September)
  - Final Consultation Event – CPS Innovations for the Future (Paris Region)

Consensus-building, awareness and dialogue on societal and legal issues.



- **Foundations activities** including
  - 1. **Humans** as part of CPS
  - 2. CPS and systems engineering – **facets of complexity**
  - 3. **Autonomy, AI and self-awareness**
  - 4. **Composability** for CPS



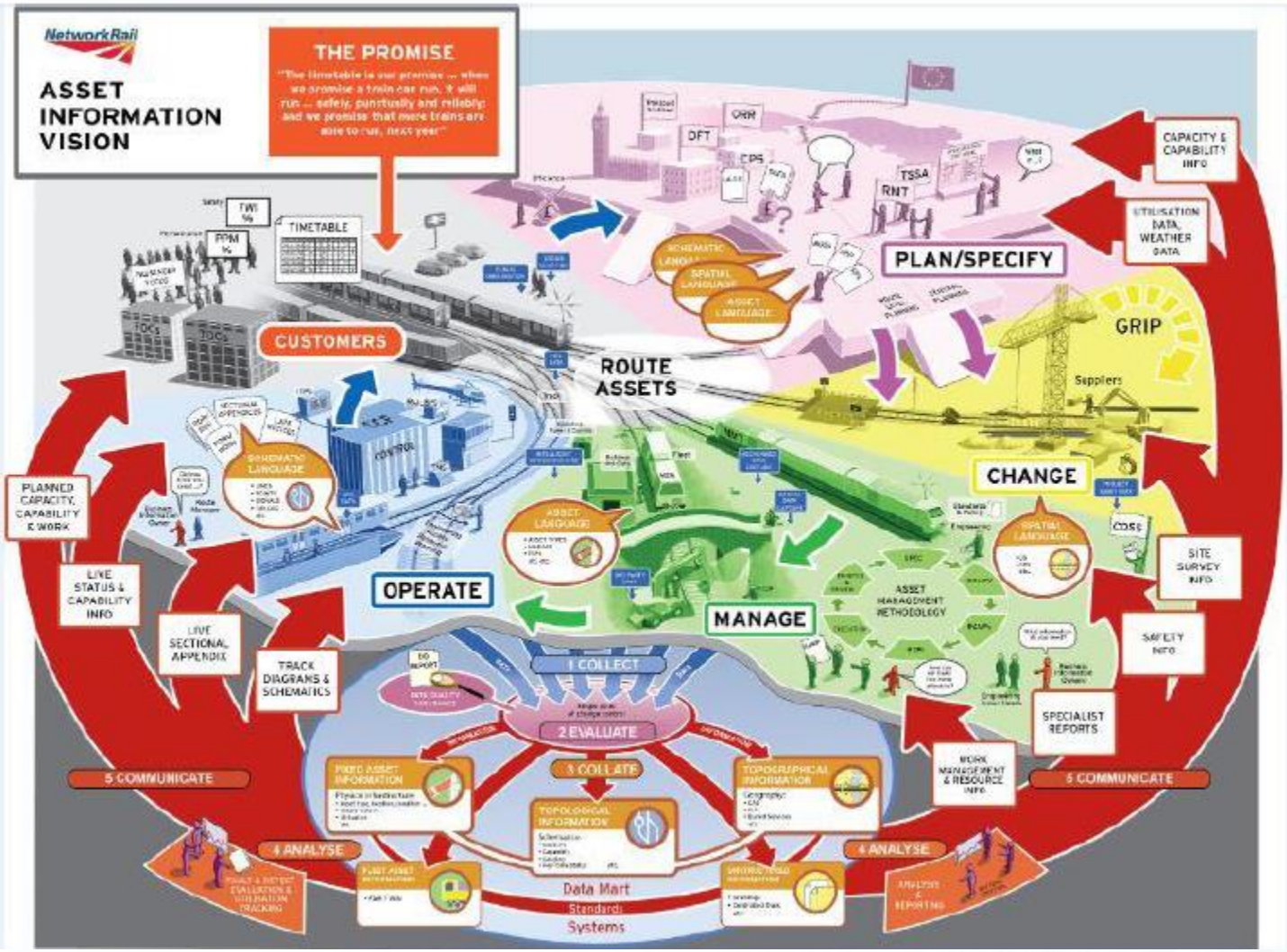
- **Societal & Legal Issues**
  - **Approach**: Desk research - 1st Questionnaire
  - Informal discussions - 2nd Questionnaire –
  - Workshop.

- **Connectivity** -privacy, confidentiality and cybersecurity for CPS/IoT
- **Legal Issues** considering risk and liability due to safety concerns of domains
- **Ethical issues of AI** considering transparency and the need ethical training
- **Social impact of Automation/Robotics** considering the threat to jobs as well as proposed approaches to address this such as a “robot tax” and Universal Basic Income

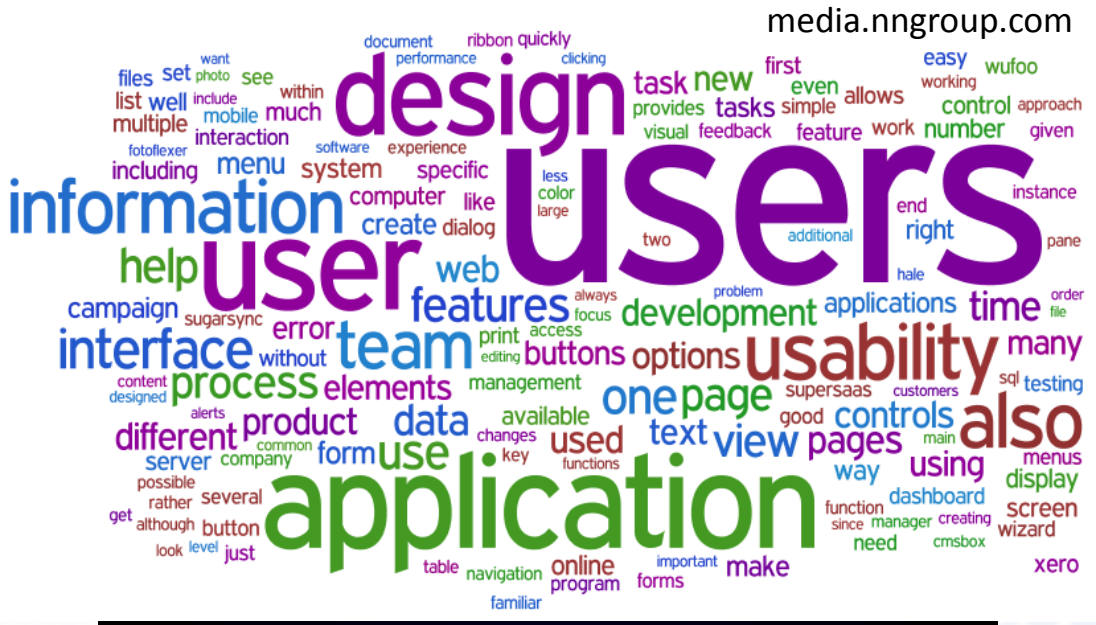
Emergent Activity: Distinguishing CPS

Transverse project activity

So which part is CPS, SoS or IoT?



Word Clouds – This is the impression CPS makes on many people



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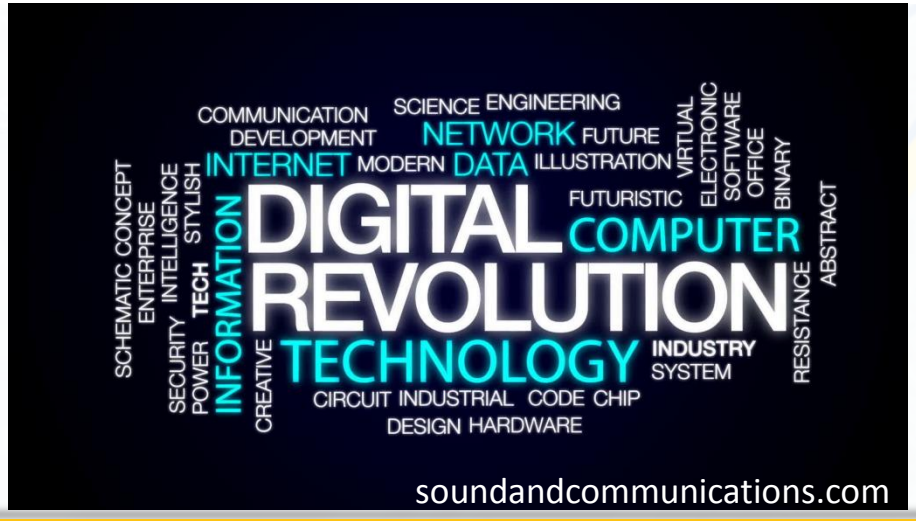


soundandcommunications.com

www.xors.com

Providing this to the Public or Policy Makers gives little insight on the impacts of funding and competition.

Distinguishing CPS – Purpose of Activity

- **CPS** encompasses a wide range of technologies, some which **overlap in other technology classes** such as SoS, AI, IoT, Big Data.
  - Most CPS definitions are based on what people see being used in such systems, rather than **what functions are indispensable**.
  - As a result many people are **ambiguous** about what the **differentiating factors** are between the classes.

- If the **public** is to understand the differences and the significance of technology classes, the **heart** (core functions) needs to be clear.

- Clarity helps improve an understanding on how different levels of research funding impacts technologies in the CPS domain.

- Improved understanding for achieving CPS momentum in research projects. Reduced misunderstandings of new technology market implementation.

- Having form can mean barriers to some innovation, but equivalently without form effective innovation is limited.

CPS and other technology classes

As a baseline, CPS is the result of increasing complexity of Embedded Systems + their interactions, having the purpose to make changes in the real world.

CPS -> Heart: **Affecting physical world** and highest level of **interactive coordination.**
-> (Sensors + Processing + Effectors) + (Inter-system coordination)

Other Classes and relationship with CPS

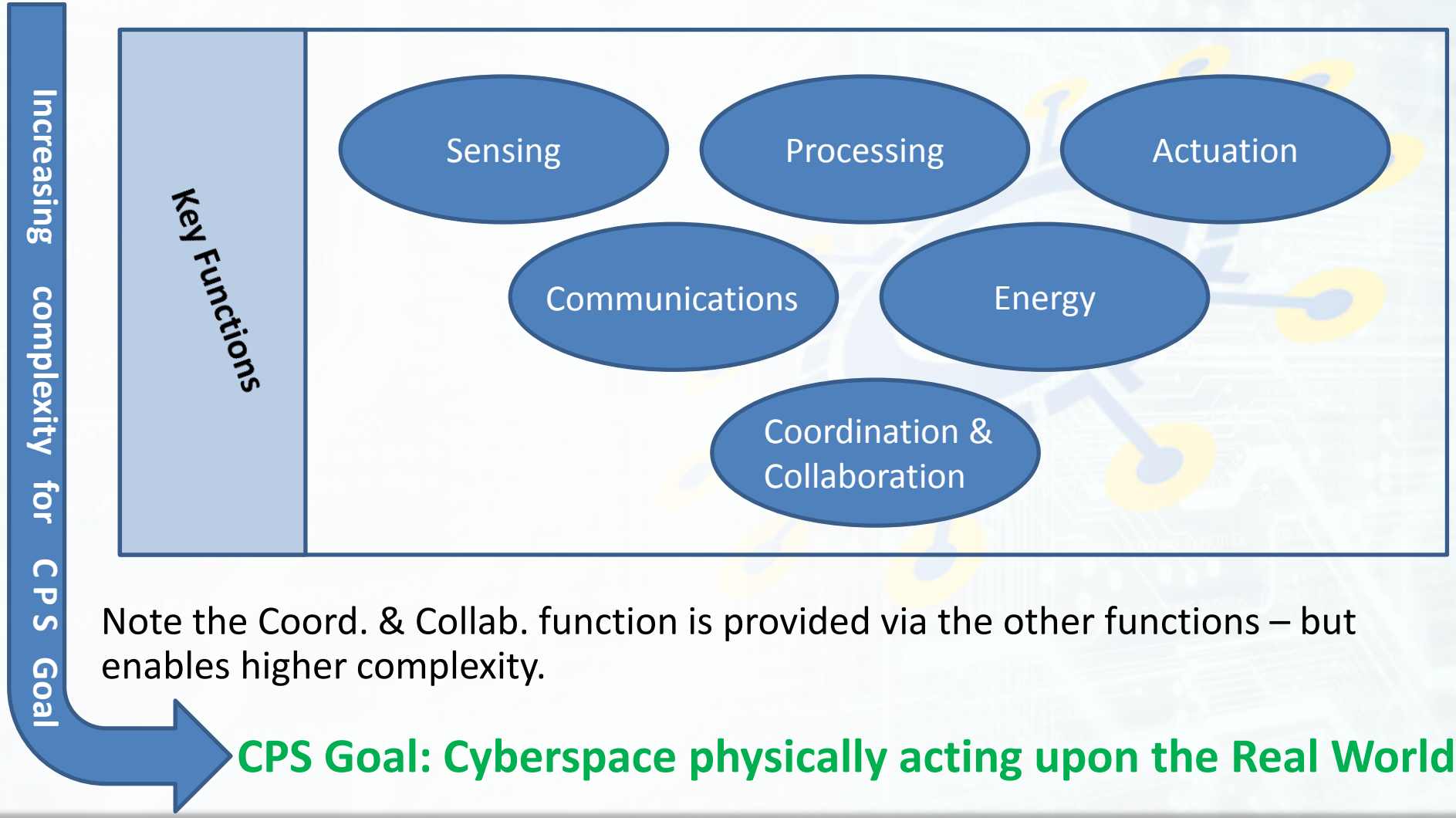
IoT -> Heart: Global connectivity -> Common device protocols and HMI
(Differences example: Embedded Systems + coordination not a necessity)

SoS -> Heart: Interactive systems
(Differences example: Embedded Systems not a necessity)

AI -> Heart: Machine reasoning -> Data and information processing
(Differences example: Embedded Systems + coordination not a necessity)

A CPS can also do without main IoT, AI, SoS technologies, but can use them for CPS core functions to help manage complexity.

CPS Key Functions (supported by software & hardware)



Note the Coord. & Collab. function is provided via the other functions – but enables higher complexity.

Advancing the Design of CPS : Managing complexity!

Higher **integration** of the **CPS Key Functions**.

- **Integration of system level properties** such as Dependability (Safety, Security, Performance) and Human factors with traceability:
  - **between product life-cycle** phases (Requirements to Retirement).
  - **within** product life-cycle **phases** (e.g. safety-security for Architecting)

- **Integration** between complex **systems**.

- **Bridges** to effectively channel input from **other technology classes** (SoS, AI, IoT, Big Data…).

- Theory advancement needed, enabling the increasing need for **integration across Technologies** and **across Disciplines**.

Ultimately for design it is about **integration methods** that **achieve systems of higher capability** based on key CPS functions. However, in existing and emerging systems, there is need for **techniques to simplify** the resulting design complexity (for example foundations and building blocks).

Complexity Levels for higher CPS Engineering

	Stage 1	Stage 2	Complexity Levels
	Linking System Properties (Co-engineering)	Connected in Product Lifecycle	4
Bridges with other Tech. classes	Linking all CPS Key Functions, for System Properties (Safety, Security, Performance, Usability)	Connected in Product Lifecycle	3
Bridges with other Tech. classes	Linking some CPS Key Functions	Connected in Product Lifecycle	2
Bridges with other Tech. classes	Sensing, Processing, Actuation, Comms., Energy, Coord.& Collab.	Connected in Product Lifecycle	1

Inside system

Outside & inside system

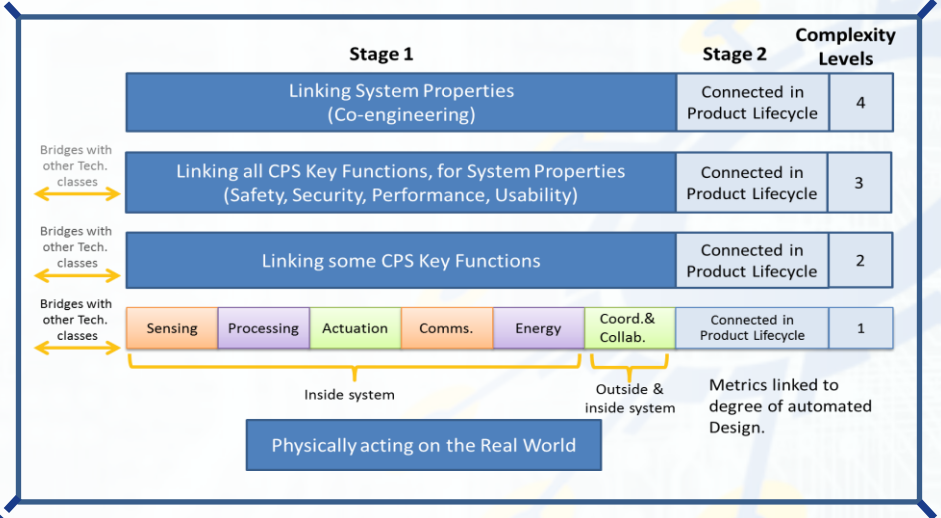
Metrics linked to degree of automated Design.

Physically acting on the Real World

Intersection point and positioning of strengths (overlap a necessity)

Cyber-Physical Systems

Strengths in the higher levels & abstraction



Smart System Integration

Strengths on the lower levels & materials

Feedback on the Distinguishing CPS is welcome!

- Again – visit the appropriate section at https://platforum.proj.kth.se

Distinguishing CPS

It is very important to have clarity on what constitutes a Cyber-Physical System (CPS) and particularly what distinguishes it from other technology domains such as Artificial Intelligence or the Internet of Things.

With respect to this, we wish to ask for your feedback on the presentation here:
https://www.platforms4cps.eu/fileadmin/user_upload/8_Structuring_for_CPS_Clarity_-_CPS_Community_Enhancement.pdf

In particular feedback for the two slides outlined below. However feel free to add
comment on (ideas for next steps welcome in the comments sections). Please us
when voting or providing arguments.

For more discussions, see platforum.proj.kth.se. This initiative provides feedback

Ideas	Pros and cons	Votes
Slide 4-Key functions of a CPS by Charles One aim here is to provide the ability of the General Public and Policy Makers to easily identify... more	At a workshop, the term "Energy" was questioned by a participant. Another participant noted EPoSS... more by Charles Robinson (Thales) In response to using only "Energy" - it is intended to cover all aspects for a CPS related to Ene... more by Charles Robinson (Thales) Add argument	1 Vote Charles Robinson (Thales)
Slide 8-Levels of complexity for CPS Engineering by Charles For the CPS Engineering Community it is also important to have clear and solid ground on which to... more	Add argument	1 Vote Charles Robinson (Thales)

Add idea

- In coming weeks a common CPS Glossary will also be going up for use in funding proposal writing.
  - This will be following a discussion with the CPS H2020 Cluster and then available for your feedback.

A few last observations

Wealth for Future Generations

- Short term wealth generation impacts long term wealth*.
  - Recent estimate that current technology should mean we are up to six times more productive - but for instance:
    - Minimum investment for short term profits.
    - Industry infrastructure insufficiently advanced for new technologies (need co-engineering).
  - Specialisation = efficiency -> but short term savings from generalisation.
  - Political instability from boom-bust cycle
- Need visionary policy making with support from technology. Also strategies that provide a level playing field so companies are not at a disadvantage from investing in long term actions.
- Evolution of value system with equal emphasis on short term value against long term value.

*See next slide.

Long Term Wealth also includes

- Levels of kindness and ability to contribute well in society.

- Quality of our infrastructure with open baselines on which to build.

- Quality of our natural environment
  - Of course pollution makes things more inhospitable but also:
  - Continued natural forest decline > 6% in last 20 years.
  - Lower levels that support animal kingdom at high risk
    - Continued sea acidification impacts shellfish, polyps, bone formation.
    - Insects declining. Regions with flying insects down 75% in last 30 years.

As the CPS domain physically interacts with the real world, it needs to take a lead in restoring the natural environment.

We each are accountable for our technologies
-**not just carbon-neutral but nature-neutral**.

Platforms4CPS in a nutshell

Platforms4CPS:
Creating the CPS Vision, Strategy, Technology Building Blocks and Supporting Ecosystem for Future CPS Platforms

Coordination and Support Action, co-financed by the EC - H2020 - ICT 1-2016: **Smart Cyber-Physical Systems**

7 Partners from 4 European countries

Coordinator: THALES Research & Technology, France, Dr. Charles Robinson
EC Project Officer: Jasna Resic

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