SPIRE

Sustainable Process Industry through
Resource and Energy Efficiency

Sebastian Engell

TU Dortmund

COORDINATED PRODUCTION
FOR BETTER RESOURCE EFFICIENCY

From unit control to optimal management of plants, sites and chemical parks

Sebastian Engell, TU Dortmund, Coordinator

Oct. 1, 2018

www.spire2030.eu/copro

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723575

COORDINATED PRODUCTION FOR BETTER RESOURCE EFFICIENCY

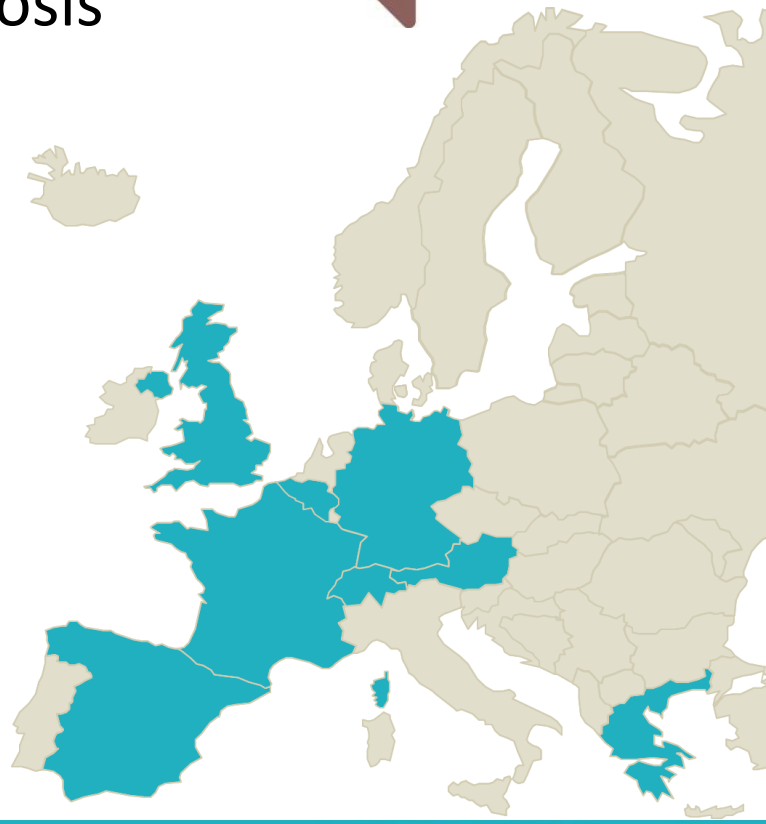
Individual units often are already automated and operated efficiently

Inefficiencies result from lack of coordination

Better coordination of production means improved energy and resource efficiency

CoPro: Short fact sheet

- Full title: **Improvement of Energy and Resource Efficiency by Better Coordination of Production in the Process Industries**
- Contributing to circular economy and industrial symbiosis
- Builds on the results of FP7 projects
  - MORE Real-Time Monitoring and Optimization of Resource Efficiency in Integrated Processing Plants
  - DYMASOS Dynamic Management of Systems of Systems
- 17 partners from 8 countries
- Duration: 42 months
- EC contribution: 6 M€



Consortium

Industry with 5 applications covering the complete value chain

covestro

P&G

Frinsa

Lenzing
Innovative by nature

INEOS
THE WORD FOR CHEMICALS

Technology providing SMEs

LeiKon

PSE

sabisu®

asm
Increasing Productivity

dvis
intelligent solutions

ORSOFT
Advanced Production Scheduling

Universities

technische universität
dortmund

Universidad de Valladolid

EPFL
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Dissemination and exploitation support

inno

Research institutes

CERTH
CENTRE FOR
RESEARCH & TECHNOLOGY
HELLAS

CSIC
Consejo Superior de Investigaciones Científicas

Mission

Improved coordination is key to better energy and resource efficiency of the existing assets

CoPro addresses coordination in three dimensions:

- Cross-layer process integration, from basic process controls to the coordination of the complete supply chain
- Cross-unit and cross-plant coordination: Integrated management and control of heterogeneous units coupled by flows of energy and materials
- Cross-functional coordination: Coordination between different functions related to production, e.g. between maintenance and operations and between operations and the procurement of electricity

Goals

Provide and demonstrate tools for process monitoring, dynamic planning, and scheduling and control of plants, sites and industrial clusters under dynamic market conditions

- Improved energy and resource efficiency by coordinated optimization of production units
- Buffering the effects of fluctuating renewable energy production and distribution by integrating demand-side response with plant-wide scheduling and control
- Efficient plant and resource utilisation by integrated plant-wide scheduling and control
- Optimization of maintenance

Innovations

Plant and site operation efficiency largely determined by discrete events and decisions	→	CoPro includes discrete decisions in plant-wide control and optimisation schemes
Plant managers and operators have a crucial role in the operation of processing plants	→	CoPro develops intuitive forms of human-machine interaction and optimisation-based advanced decision support
Suitable mathematical models in most cases are only available for some important plant or units	→	CoPro develops techniques for coordination of production units that can employ models of different types
Operation of plants of different companies in industrial parks that are connected by energy & material streams are not coordinated	→	CoPro develops technology for balancing and optimising networks, and for distributing the joint benefit in industrial parks

Industrial use cases: INEOS in Cologne

INEOS
THE WORD FOR CHEMICALS

Optimal site and cracker planning and scheduling including optimisation of plants operations and DSR

Alexander Gammersbach
Team Leader of
Site Optimisation
INEOS Köln GmbH

"We operate a petrochemical complex with interacting plants and produce a large number of base chemicals. We need to plan this production for at least the year ahead. With optimal planning of the site and optimisation of some of our units we can react quickly to changes in the market and save resources and energy."

INEOS in Cologne USE CASE – NH_3 network optimisation

Improving the coordination of strongly coupled production plants

- Generation of an optimal schedule for the operation of the plants in the ammonia network
  - Time horizon one month or more
  - Includes logistics
  - Optimization of plant loads and cold storage
  - Improved resource usage
  - Demand side response

Wenzel et al. “An Optimization Model for Site-Wide Scheduling of Coupled Production Plants with an Application to the Ammonia Network of a Petrochemical Site.” (submitted)

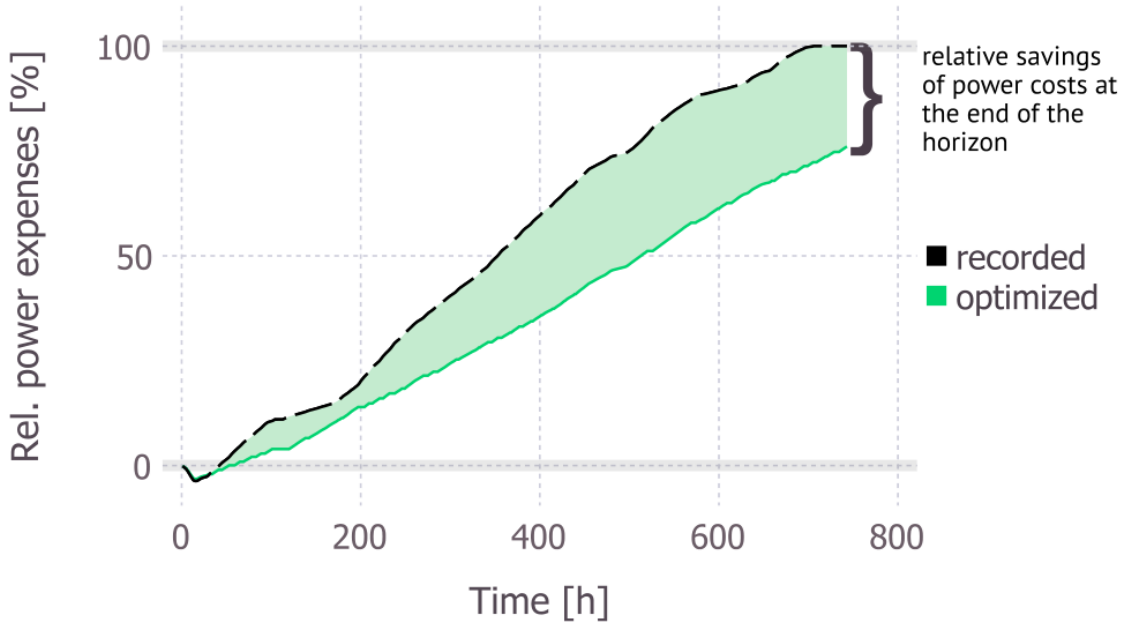
INEOS THE WORD FOR CHEMICALS

technische universität dortmund

LeiKon

INEOS in Cologne USE CASE – NH_3 network optimisation

- The optimisation model contains
  - Mass balances
  - Operational constraints
  - Equipment limitations
  - Logistic constraints
  - Production targets
  - Negotiated deliveries
- Simulation results were obtained for a 31 days scenario



Large saving potential identified if the network operations are performed in an optimal fashion compared to recorded data

Wenzel et al. "An Optimization Model for Site-Wide Scheduling of Coupled Production Plants with an Application to the Ammonia Network of a Petrochemical Site." (submitted)

Industrial use cases: Covestro

Coordination of production & distribution of gases in a chemical complex

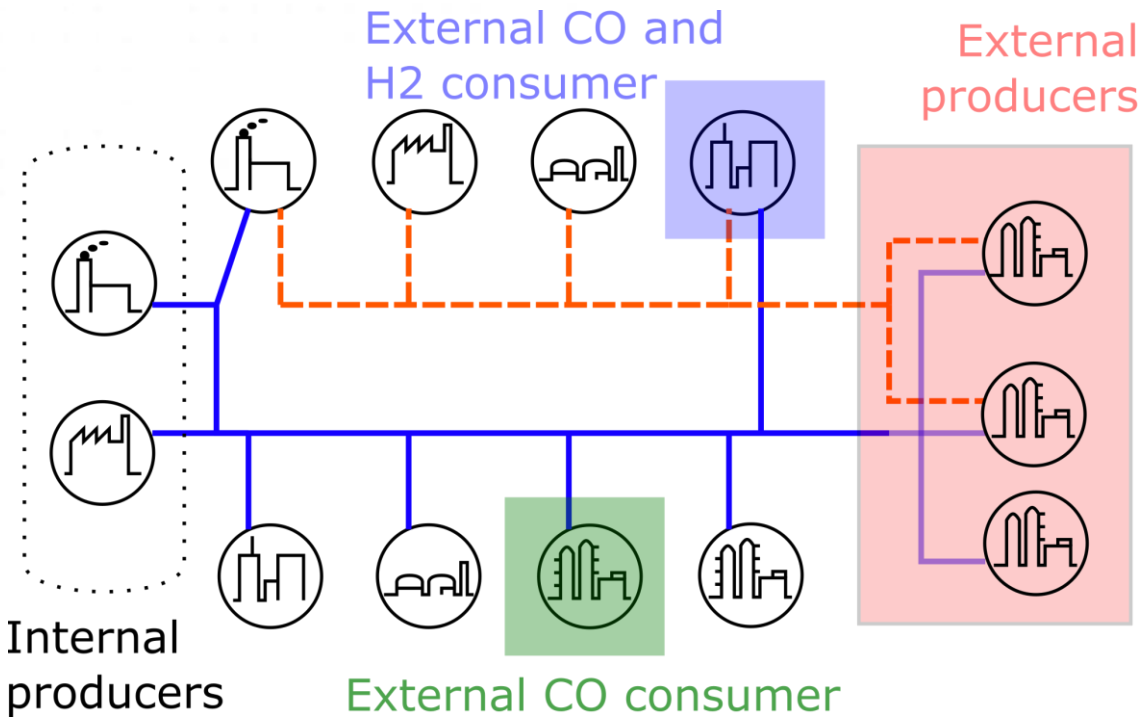
Christine Maul
Team Lead of
Advanced Process Control
Covestro Deutschland AG

"We strive to optimize the production and distribution of basic chemical gases required in the synthesis of our polymers. By means of advanced modelling, monitoring and optimization methods, we want to improve the energetic efficiency in the production of gases while respecting environmental and safety regulations."

Covestro USE CASE – CO and H_2 network optimisation

Balancing the networks by coordinating

- Internal production
  - Considering fluctuating electricity prices
- Internal consumption
- External consumers
- Purchases from external producers
  - Minimum purchasing quantities
  - Coupled contracts with different tariffs
  - Cashback for yearly targets
- Transfer of gases between sites



Maxeiner et al., (2018) "Price-based coordination of interconnected systems with access to external markets," PSE 2018, San Diego, USA

Improving economics and resource efficiency by reducing waste streams and demand side response

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covestro

Industrial use cases: Lenzing

Lenzing
Innovative by nature

Optimal process coordination for the recovery section of EU's largest viscose fiber production plant

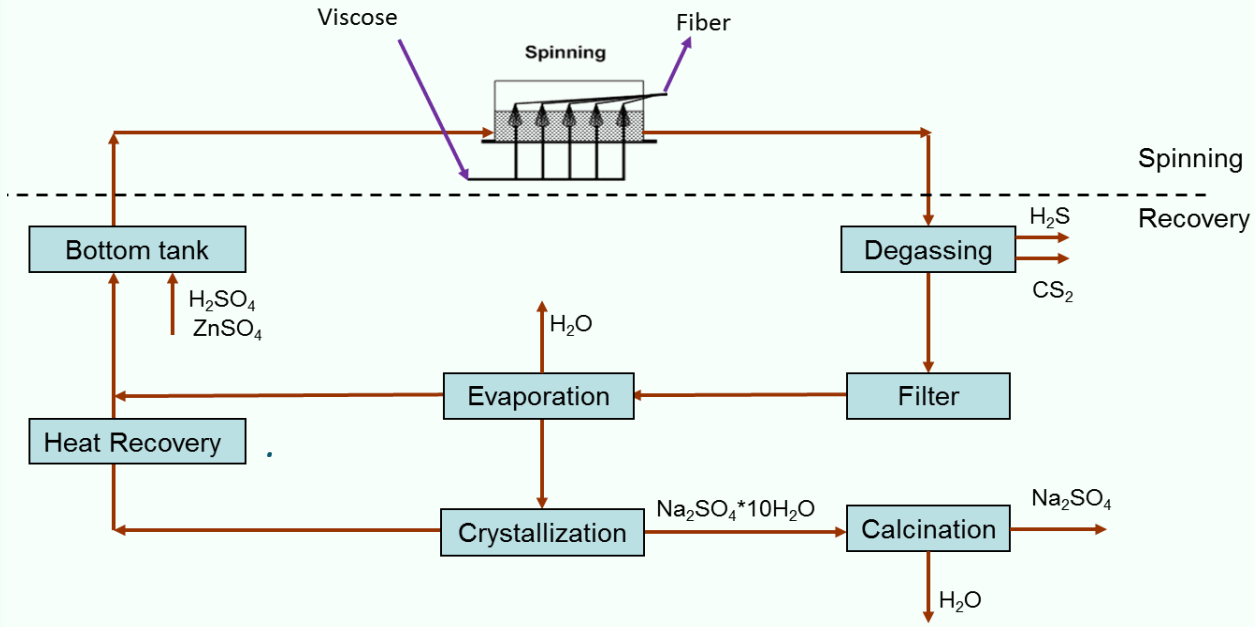
Christian Jasch
Process Engineer
Recovery & Spinbath
Lenzing AG

"The recovery of the spinbath is the key process step in the viscose fiber production with the highest energy demand. Especially the spinbath reconcentration by evaporation requires a huge amount of heat. In CoPro our goal is to improve our multi-unit evaporation process by focusing on load allocation, cleaning cycles, cooling water distribution and the heat recovery."

Lenzing USE CASE: Spinbath recovery system

Lenzing
Innovative by nature

Cross-unit and cross-functional coordination of the recovery cycle in Europe's biggest cellulose fiber plant



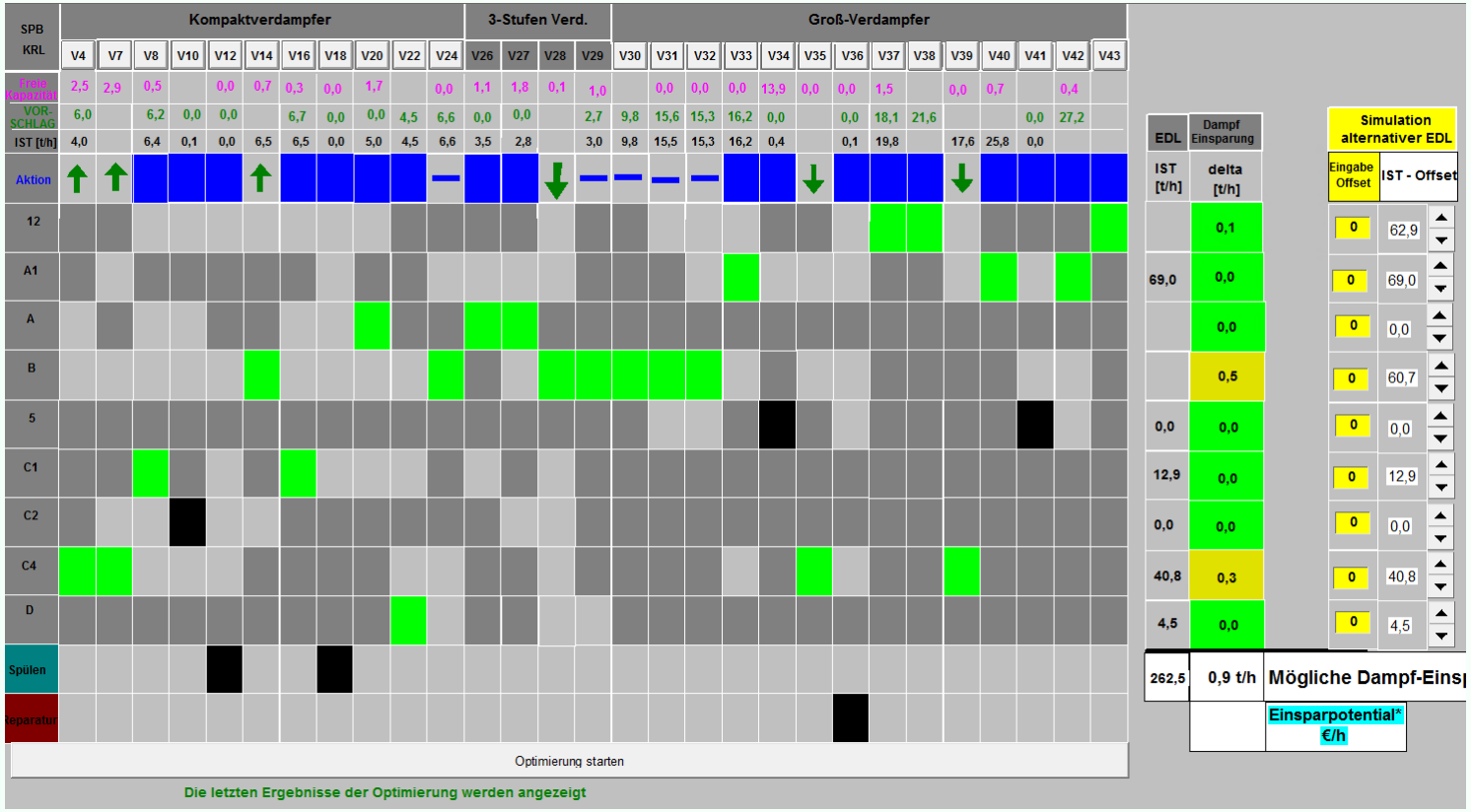
The recovery cycle of Lenzing's viscose fibre plant in Upper Austria

Objectives:

- Efficient load allocation in the multi-unit evaporator network
- Cleaning sequence coordination for the evaporator and heat recovery section
- Optimized cooling water distribution in the recovery cycle

Lenzing USE CASE: Decision support system

Lenzing & TUDO developed a model based decision support system for a more efficient evaporator load allocation



HMI of the Decision Support System implemented in Lenzing control room

- Fully implemented in the control room in August 2018
- **1.8% more efficient operation**
- **Steam savings around 1200 t/month**
- **≈ 250.000 €/year savings**
- v2.0 Update with semi automatic control currently under development

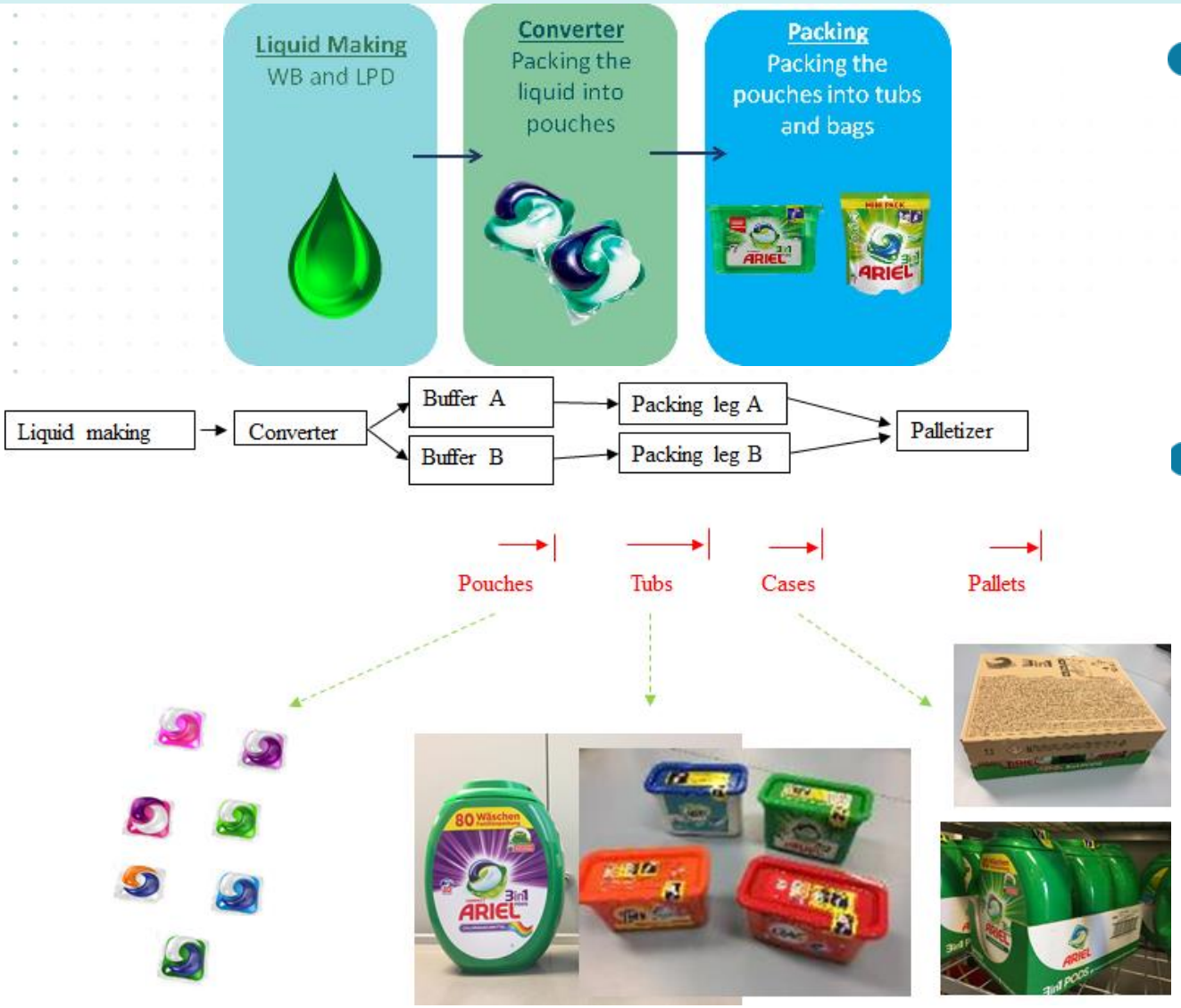
Industrial use cases: P&G

Optimisation of production and packing of consumer goods products

Francesc Corominas
Principal Engineer
Procter & Gamble

"We produce a large number of similar products in the same plant and with the same equipment. The process of fitting all products in the daily schedule and the change from one product to the other makes it all quite complex and often not optimal. The main objective in this project is to increase the plant productivity by means of optimal planning and optimal and efficient utilization of assets, resources and energy. "

P&G USE CASE



- Challenges
  - Demand-driven production
  - Great variety of products, sequence-dependent changeovers
  - Plant-wide manual scheduling not possible for longer time horizons
- Benefits
  - Reduction of waste due to changeovers
  - Optimised schedule translates into increased energy and resource efficiency
  - Improved production capacity and flexibility
  - Less work on weekends

Industrial use cases: Frinsa

Plant-wide control of the sterilisation and packaging of food

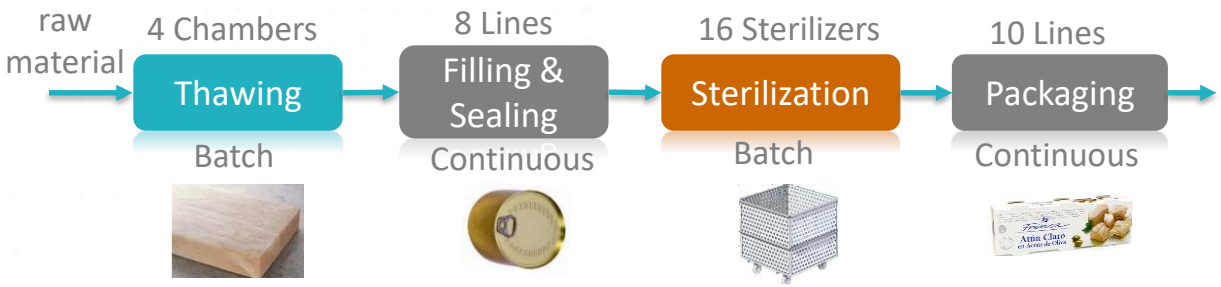
Jose Manuel García Lampón
FRINSA Production Manager
Frinsa del Noroeste, S.A.

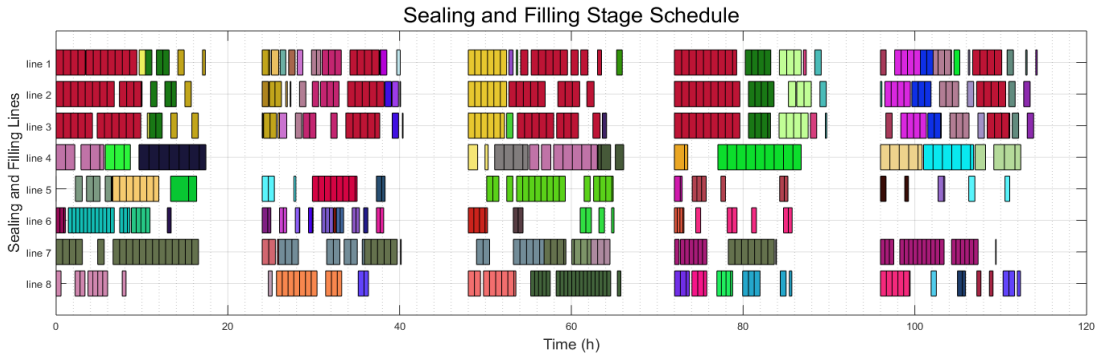
"At FRINSA, we produce over 400 different products on shared production equipment. Our main challenge is to optimally plan, schedule and operate the equipment to minimize queues, idle times and consumption of energy. CoPro technology will replace manual scheduling methods and will improve the energy efficiency and reduce total costs."

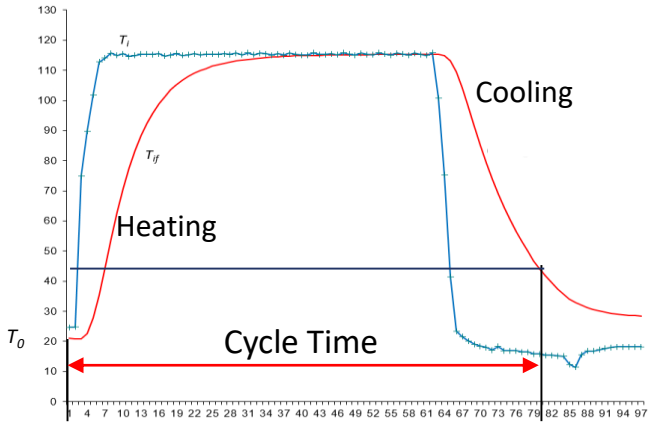
FRINSA Case Study

- General characteristics
  - Large order-driven production with high production flexibility
  - **Sterilization:** Most critical element
    - Ensures food safety & product quality
    - Energy intensive process
    - Production bottleneck
- Main challenges
  - Optimisation-based reactive scheduling
  - Optimization of the sterilization process ➔ significant energy savings by better control and coordination with scheduling

  Trade-offs between
    - Productivity (higher temperatures, faster sterilization)
    - Energy consumption (lower temperatures, longer processing times)

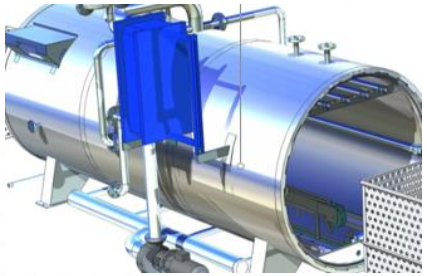




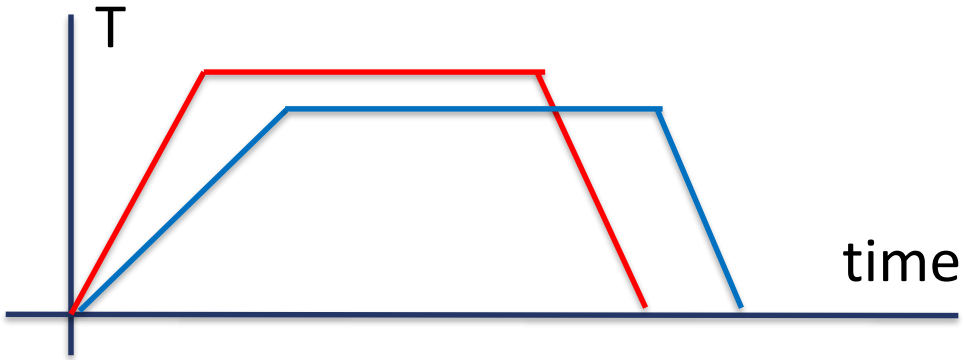


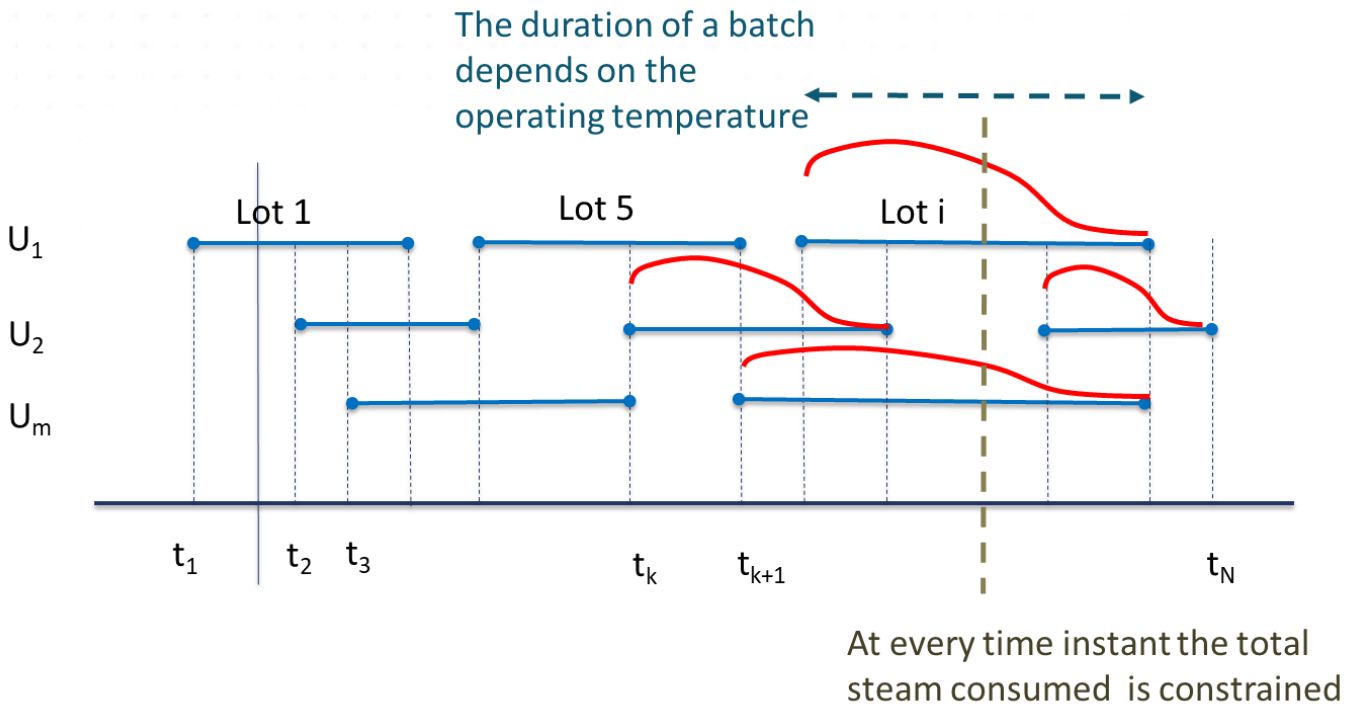
Frinsa: Integrated scheduling and optimization of the sterilizers

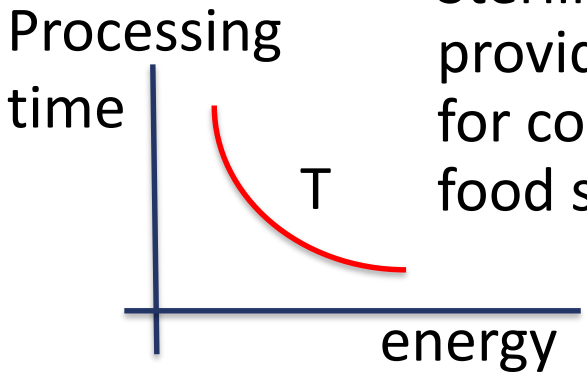
Operating the sterilizers at lower temperature saves energy, ~ 500 Kg steam /ºC and batch but increases the processing time



Integrated scheduling and unit optimization for balancing of energy minimization and through-put maximization



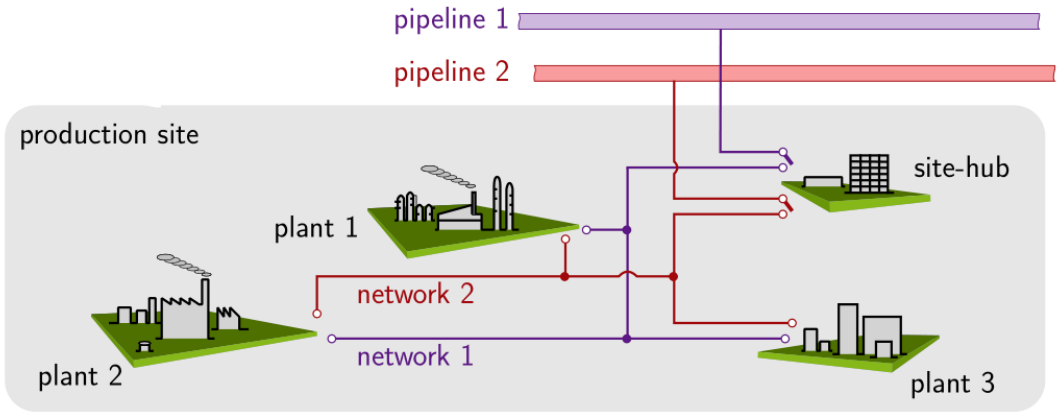




Sterilizer optimization provides Pareto front for complying with food safety

Outlook – Distributed coordination

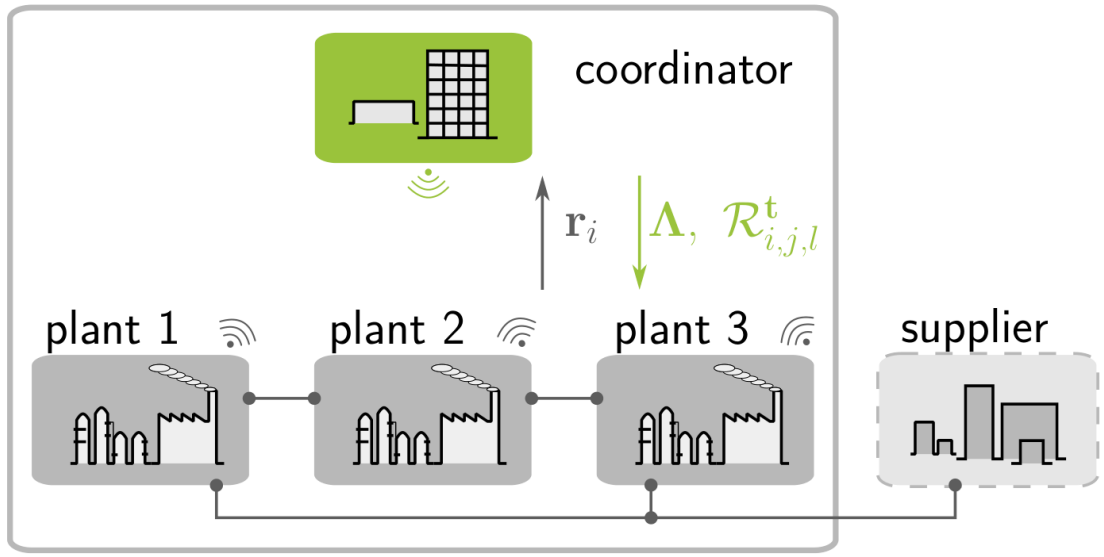
- Hurdles for solving such integrated optimisation problems
  - Missing information
  - Complexity of the problem
  - Scalability and adaptation to changes
  - Heterogeneous modelling approaches
  - Agility
  - **Confidentiality of information**



Finding the system-wide optimum by centralized optimization is often not practically implementable

Outlook – Distributed coordination

- **Solution approach:**
  Market-like distributed optimisation
  - Intuitive concept in accordance with current accounting systems
  - Scheme mimics an auction mechanism
  - Online adaptation of the prices by the coordinator (central function)
  - Only limited data exchange between the subsystems required (resource production/ consumption)



Wenzel et al. (2018). "Virtual Splitting of Shared Resource Networks for Price-Based Coordination with Portfolio Tariffs." ESCAPE28, Graz, Austria

CoPro Technologies and tools

- Plant-wide and site-wide optimisation of operating points and discrete decisions including demand side response
- Distributed optimization using market-like algorithms to coordinate with minimum exchange of information
- Technology for optimising changeovers, reducing waste, rework and energy consumption and increasing throughput
- Reactive scheduling to maximize utilisation of the equipment and to minimize energy consumption

CoPro Technologies and tools

- Online data analytics for the detection of quality and equipment problems from available sensor information
- New modelling techniques to build models for advanced control and plant-wide optimisation efficiently
- Novel forms of information presentation to managers and operators that lead to a symbiosis of operators and computer-based optimization algorithms
- Software platform that connects to different IT systems and to visualization systems and facilitates the engineering and maintenance of integrated control and optimisation solutions

Expected impact

- 10% improvement of energy and resource efficiency if implemented fully and along the value chains across all applications and sectors
- High impact on the competitiveness of all individual partners by being first using the technologies; fast followers expected after dissemination and interaction with stakeholders
- Strategic partnership between the CoPro SMEs and large industrial companies
- Long term growth in employment at technology providing partner SMEs
- **Contribution to circular economy and industrial symbiosis**

Outlook: Dynamic management for industrial symbiosis

- **Industrial symbiosis:** *Tight coupling of production units by streams of material and carriers of energy*
- Similar to Verbund-sites, but between different companies
- Available/ requested amounts of material or energy carriers depend on the operating conditions of the plants involved which are operated by different companies
- Each company has to react to customer demands, availability of green power, etc.
  →***Propagation of variability between the plants***
- *Integrated management* is needed to realize the potential of industrial symbiosis!
- Must include *sharing of benefits* in a fair manner
  - Without violating anti-trust regulations!

Contacts

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- LinkedIn:
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- ResearchGate:
  https://www.researchgate.net/project/CoPro-Coordinated-Production-for-Better-Resource-Efficiency

Sustainable Process Industry through
Resource and Energy Efficiency

Wolfgang Gerlinger

BASF

Sustainable Process Industry through
Resource and Energy Efficiency

Matti Vilkko

Tampere University of Technology

COCOP

Coordinating Optimisation of Complex Industrial Processes

Matti Vilkko

Towards Industry 4.0: Digital Technologies in Process Industry

1.10.2018

Horizon 2020

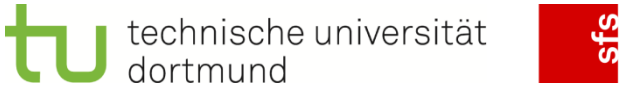
@CocopSpire

Outline

- COCOP intro
  - Pilot cases: Copper, Steel
- Optimisation and decomposition
  - Plant-wide approach
- Communication architecture
- COCOP Concept
  - Integration of optimisation, communication technologies and human factors

Consortium

- **12 partners**
  - 5 research organisations and
  - 7 companies, 4 of which are SMEs
- **Copper, steel, nutritional** and **materials products, automation technology providers, consultancy** and **software**



Universities

Technological Research Centers

SMEs

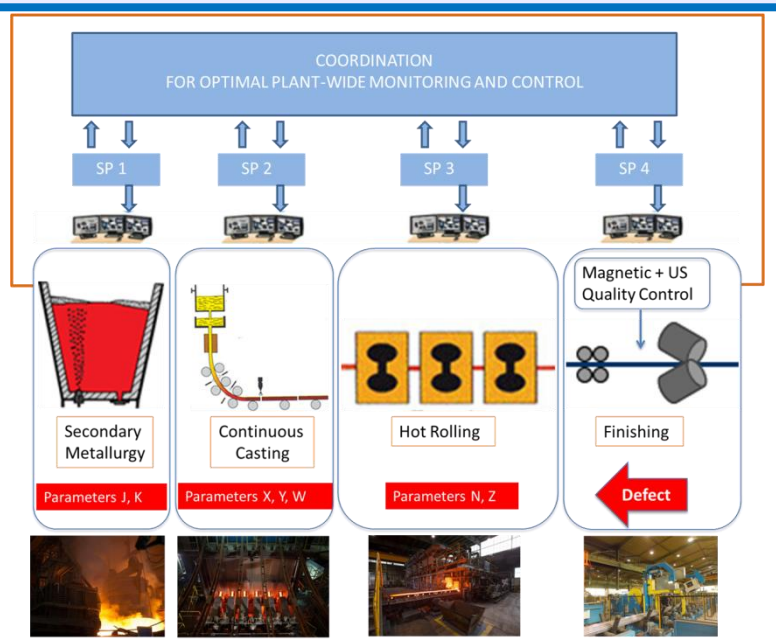
Large companies

Pilot Cases

- **On-site application and validation at two plants**

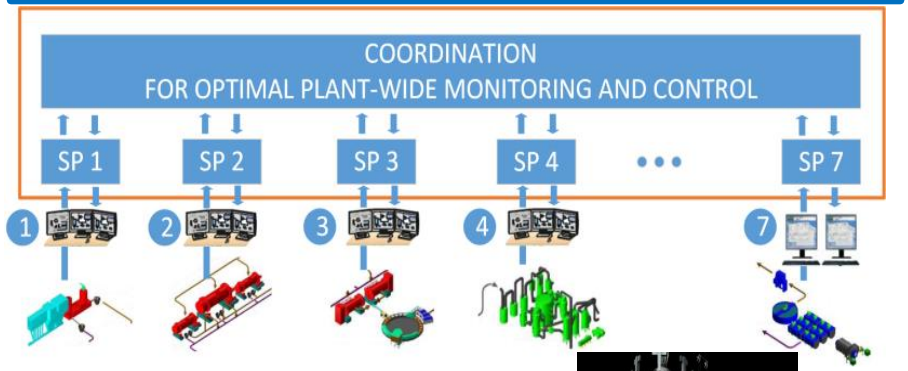
STEEL pilot case

- Development of a steel manufacturing plant-wide monitoring and control tool in order to **reduce the surface and sub-surface defects** in micro-alloyed steels in as-rolled state
- Addressed sub-processes: Secondary metallurgy, continuous casting and hot rolling



COPPER pilot case

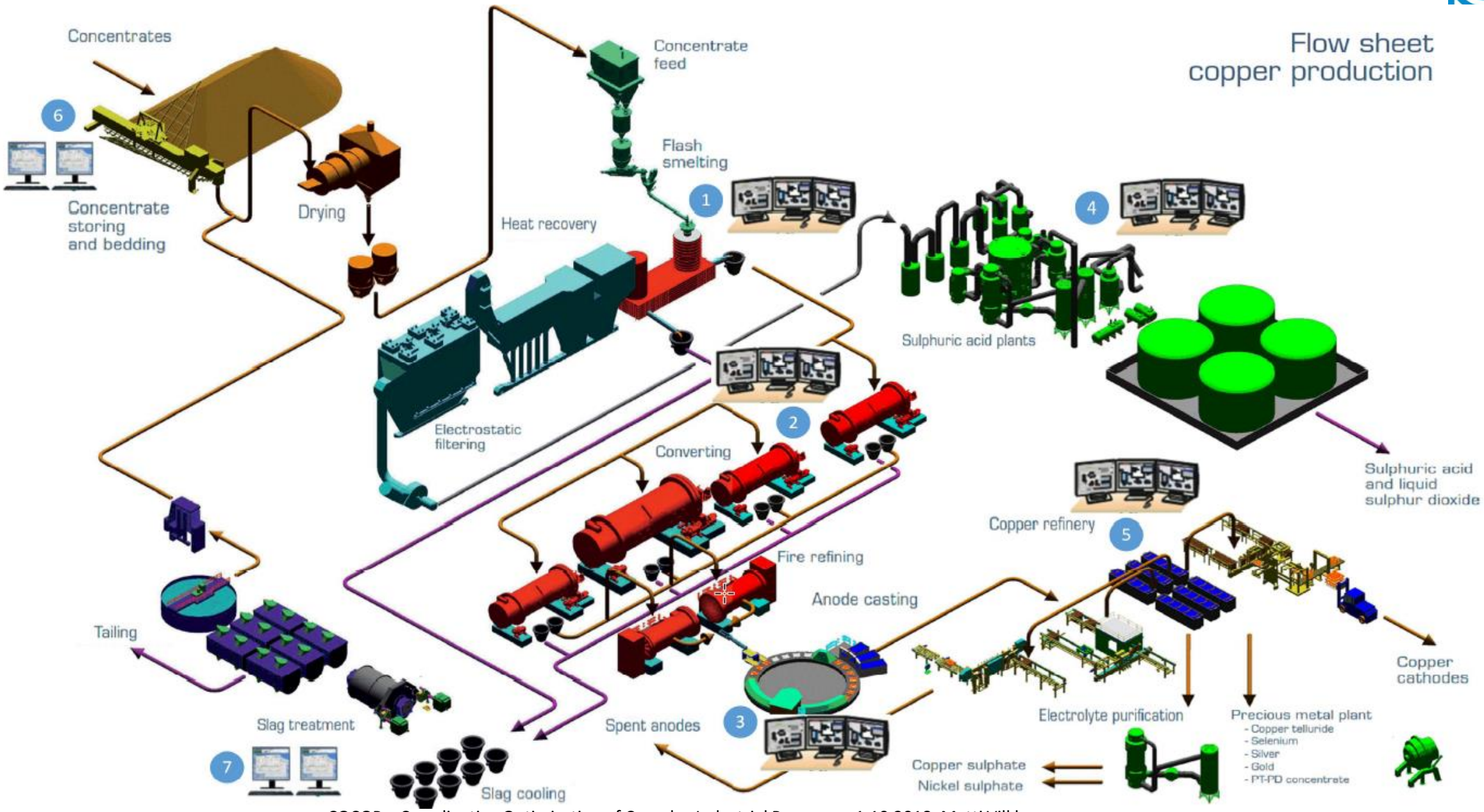
- Development of advisory tools for controlling unit processes to **improve** factors such as **temperature, slag chemistry and impurities**
- The optimization will comprise of converter and anode-furnace scheduling & setting target matte grades and feed rates of flash-smelting furnaces



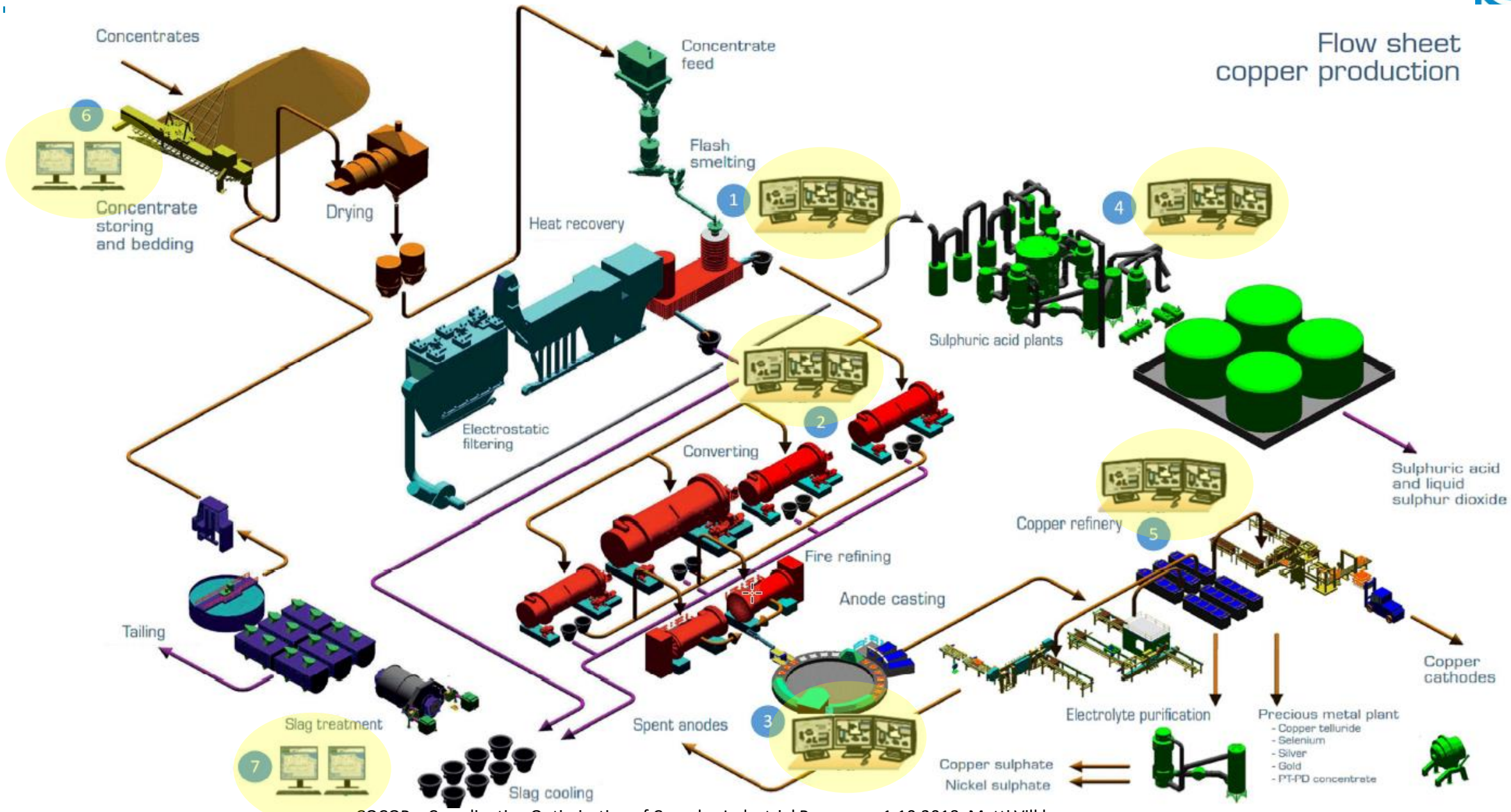
Flash Smelting Furnace

- **Transferability analysis** to other sectors: **chemical** & **water treatment processing**

Copper smelter



Copper smelter control rooms

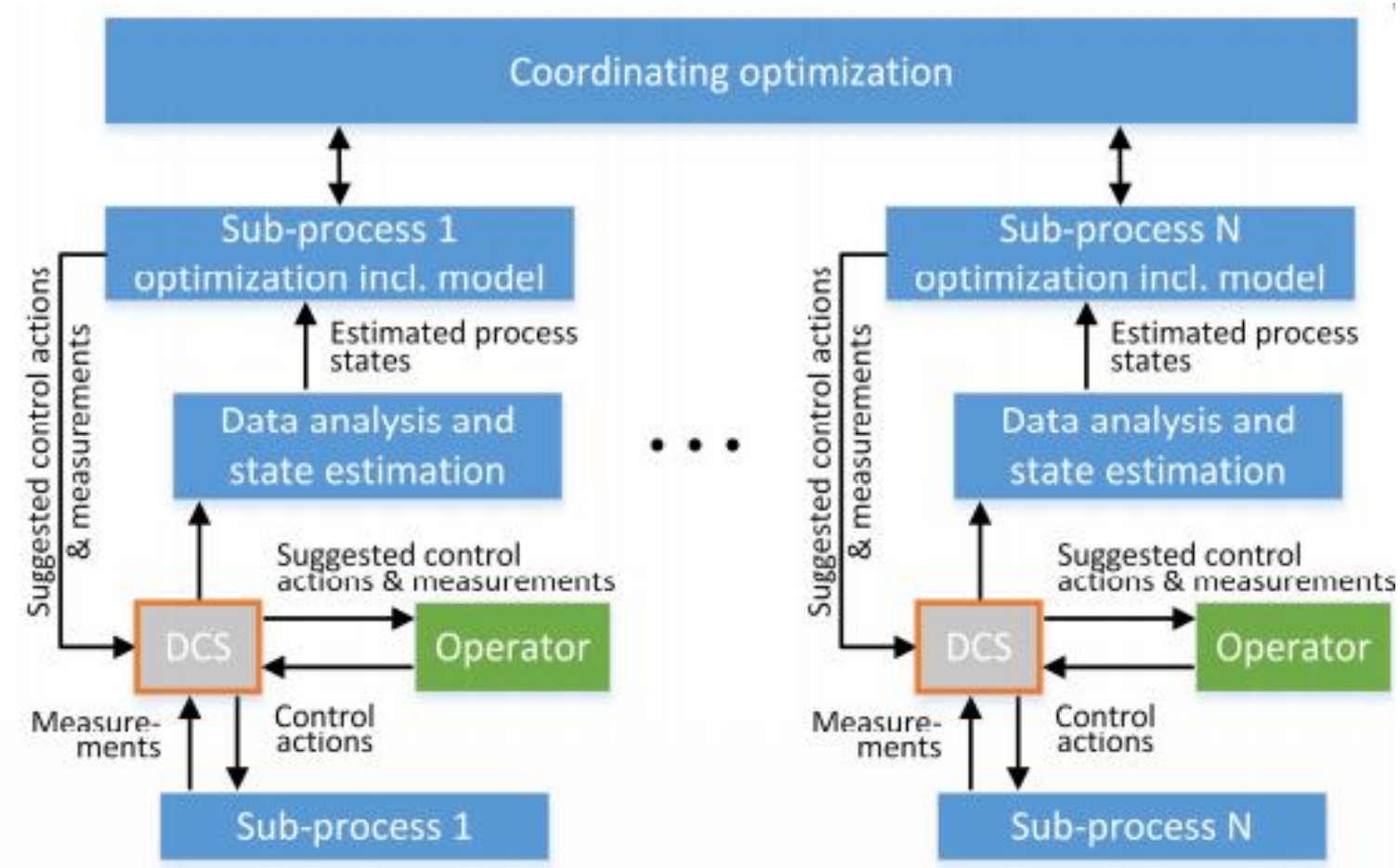


Motivation and Objectives

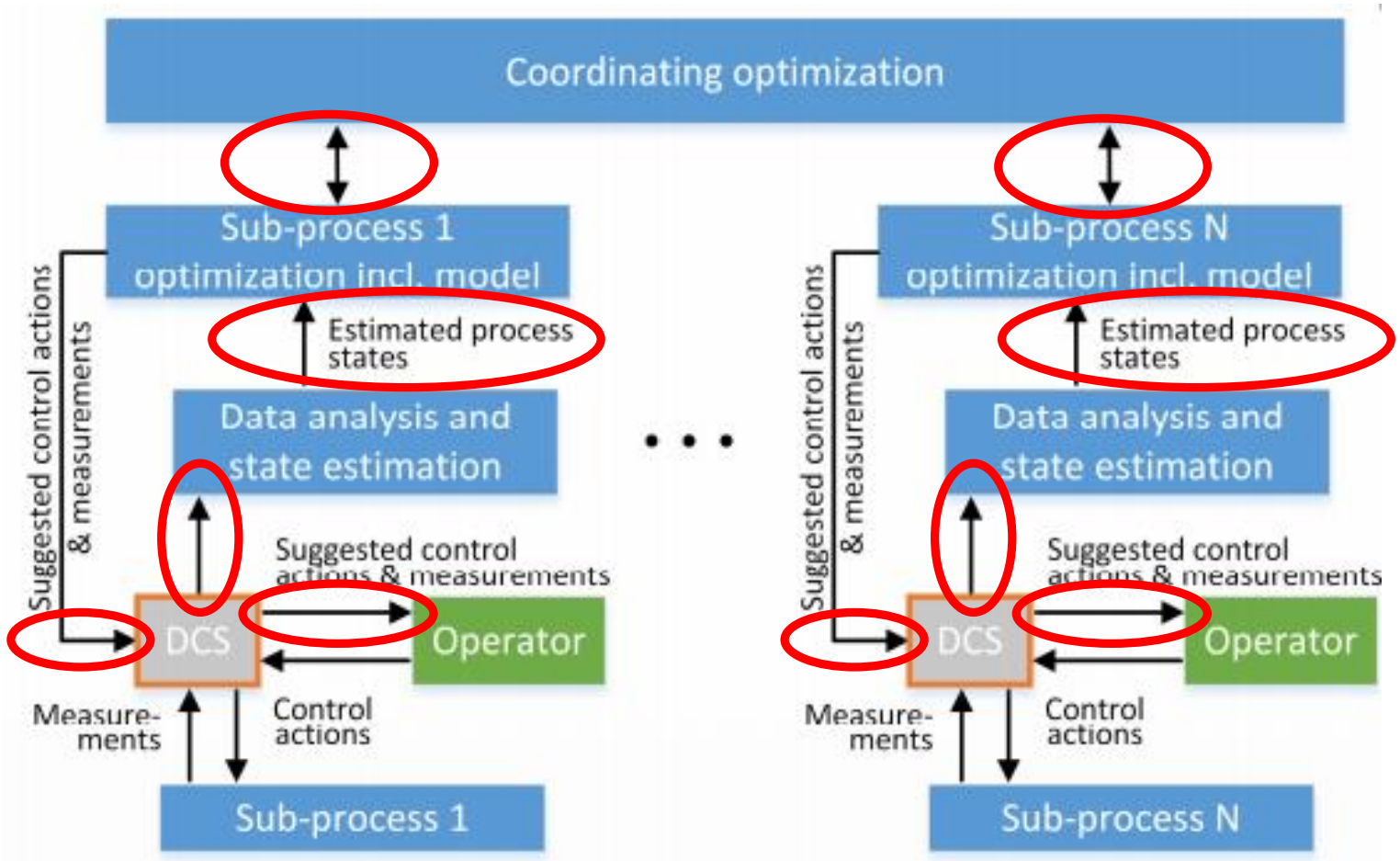
Vision	Complex process industry plants will be optimally run by the operators with the guidance of a coordinating, real-time optimisation system

Objectives	To enable plant-wide monitoring and control by using the model-based, predictive, coordinating optimisation concept in integration with local control systems

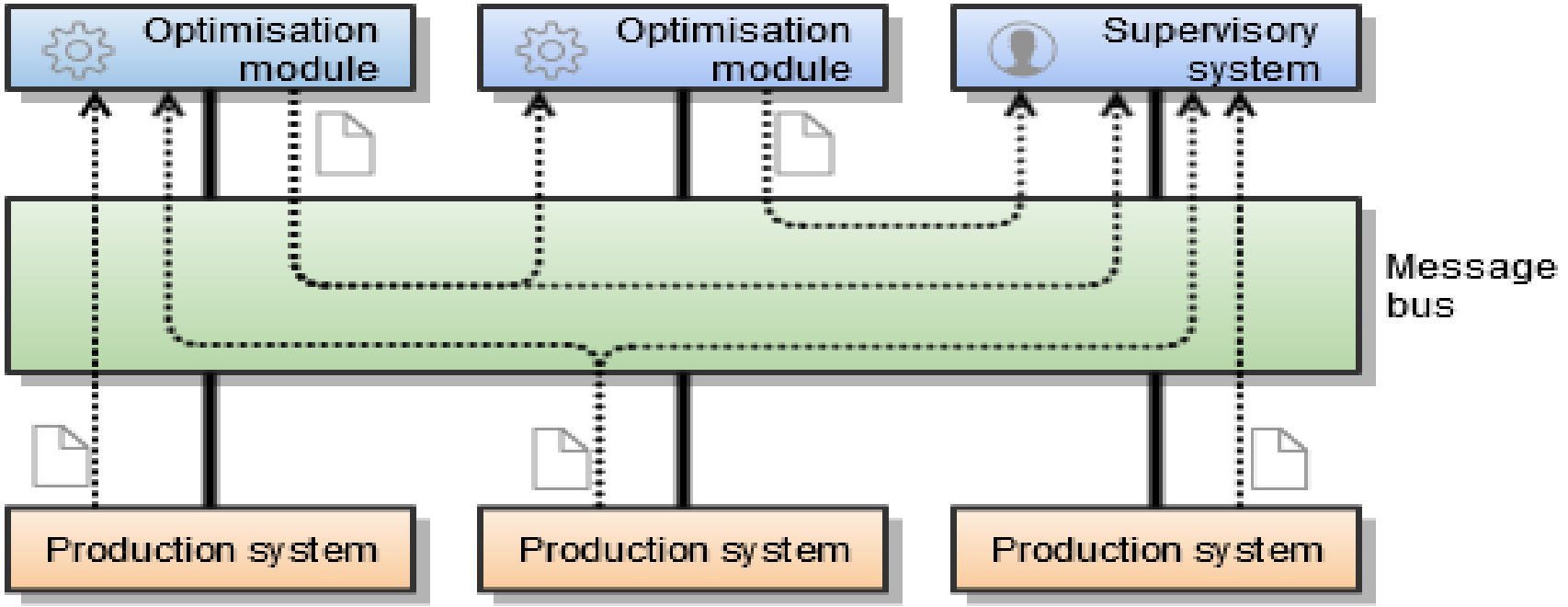
Optimisation arhitecture: decomposition and coordination

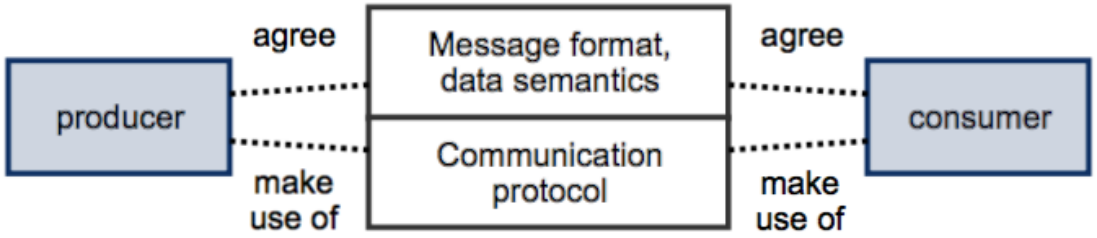


Information models and communication in COCOP

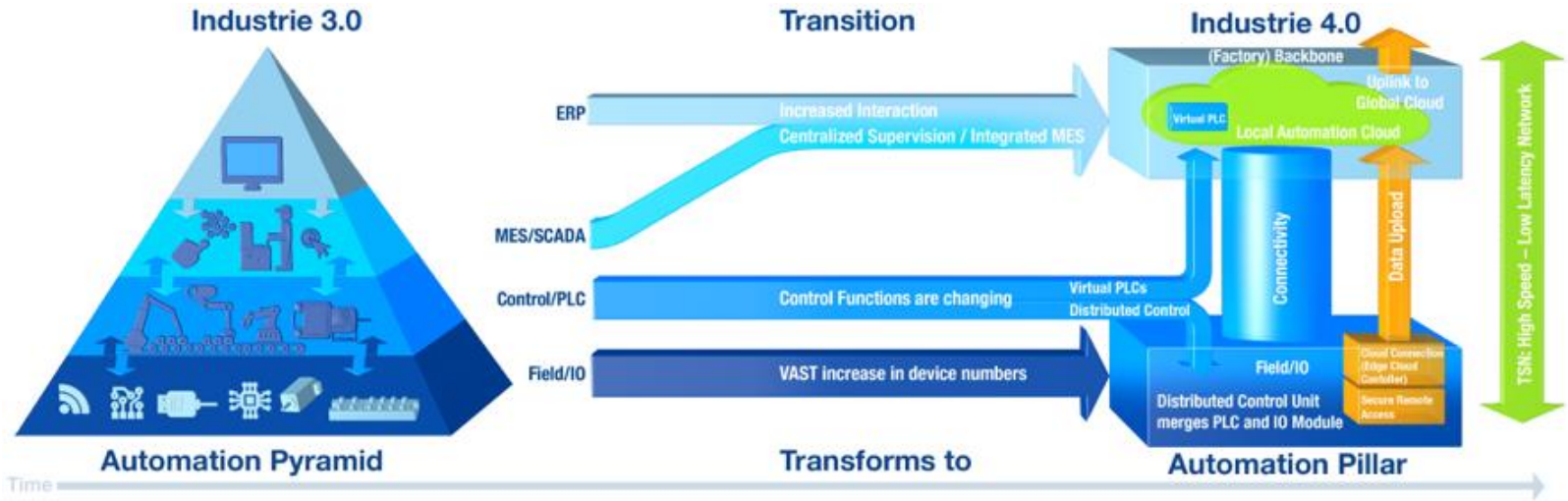


COCOP communication based on a message bus

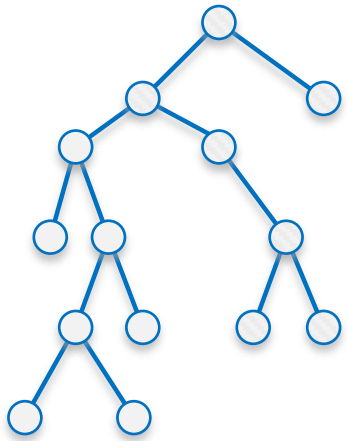


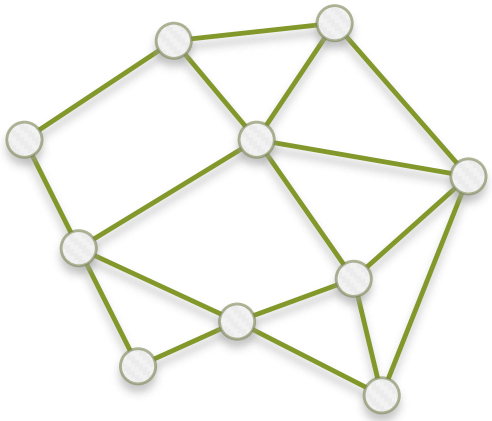


Conclusion – Convergence of Internet based approach and traditional process automation



https://www.automationworld.com/automation-networks-pyramid-pillar





Upcoming Workshop

DIGITIZED OPERATIONS for SUSTAINABLE PROCESS INDUSTRIES

FREE ATTENDANCE
REGISTRATION REQUIRED!!

DECHEMA - Frankfurt am Main, Germany

18 October 2018, 9:30 – 20:00

Participation of A.SPIRE, EFFRA and EC DG Research and Innovation

General details

- Project Start Date: 1st October 2016
- Project End Date: 31st March 2020
- Project duration: 42 months
- Grant Agreement n.: *723661*
- Sub-programme area: SPIRE-02-2016, H2020-IND-CE-2016-17
- Web page: *www.cocop-spire.eu*
- *@CocopSpire*

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Thank you for your attention!

www.cocop-spire.eu

@CocopSpire

Horizon 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723661

Sustainable Process Industry through
Resource and Energy Efficiency

Claudio Pastrone

ISMB

MONSOON
MOdel based coNtrol framework for Site-wide OptimizatiON of data-intensive processes

MONSOON project: Boosting the development and deployment of data enabled predictive control solutions for process industries

Claudio Pastrone, ISMB

Towards Industry 4.0: Digital Technologies in Process Industry

Bruxelles, October 1st, 2018

Outline

- Project Overview
- MONSOON Vision
- Use Cases
- First Achievements

PROJECT OVERVIEW

INTRODUCTION TO MONSOON

Context and main challenges

- Process industries characterized by **intense use of raw resources and energy**, where even small optimizations can lead to high absolute savings both in terms of economic and environmental costs
- Deployment of **model-based predictive functions** not always feasible at a sustainable cost or with sufficient reliability
- **Change** in global competition and resources availability calls for a drastic re-design of production processes and sites

MONSOON at a glance

- MONSOON is a **36-months** **R**esearch and **I**nnovation **A**ction (**RIA**) funded by the EC (H2020 **SPIRE-02-2016**)
- **Scope**: Plant-wide monitoring and control of data-intensive processes
- **Aim**: improve **process efficiency** and **reduce usage** of **resources** as well as **GHG emissions**, thus strengthening the global position of EU process industry
- **Total cost**: about 5.5 M€

Consortium Overview

Coordinator

ISMB Istituto Superiore Mario Boella

Fraunhofer FIT

TECHNICKÁ UNIVERZITA V KOŠICIACH

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

RioTinto

Capgemini

probayes

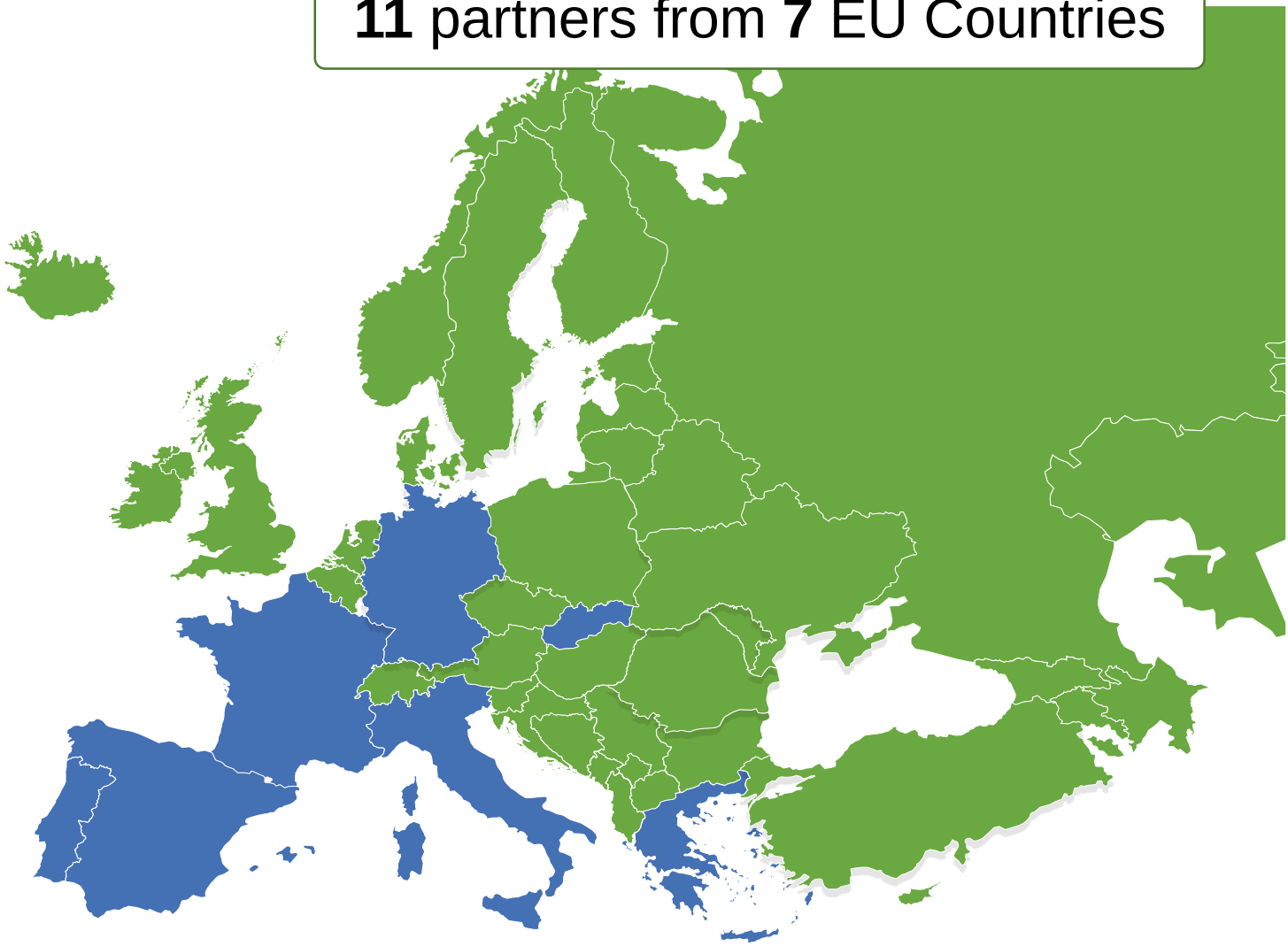
GLN Molding the Future

KUNSTSTOFF INSTITUT LÜDENSCHEID

UNE Normalización Española

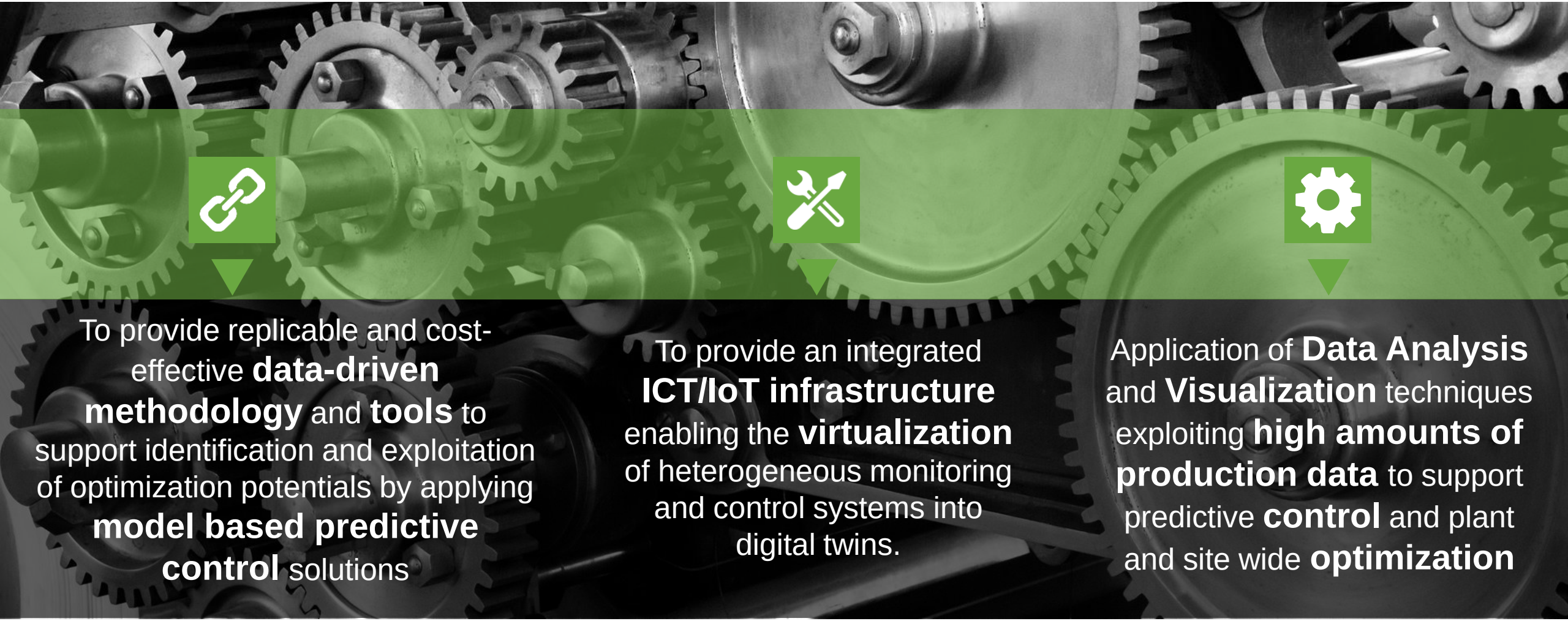
LIFE CYCLE ENGINEERING we support your sustainable business

11 partners from **7** EU Countries



MONSOON VISION

MONSOON Objectives



To provide replicable and cost-effective **data-driven methodology** and **tools** to support identification and exploitation of optimization potentials by applying **model based predictive control** solutions

To provide an integrated **ICT/IoT infrastructure** enabling the **virtualization** of heterogeneous monitoring and control systems into digital twins.

Application of **Data Analysis** and **Visualization** techniques exploiting **high amounts of production data** to support predictive **control** and plant and site wide **optimization**

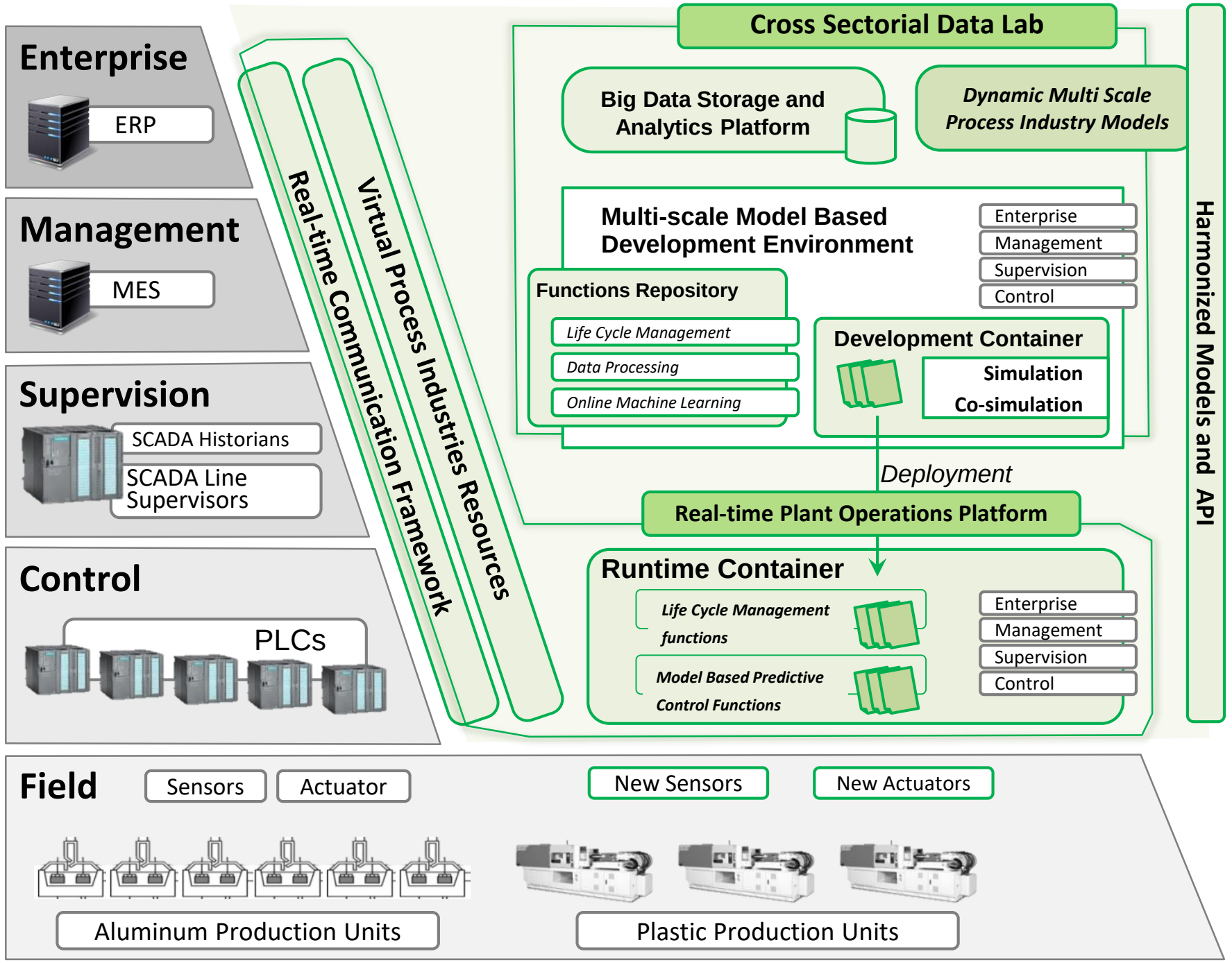
MONSOON Objectives

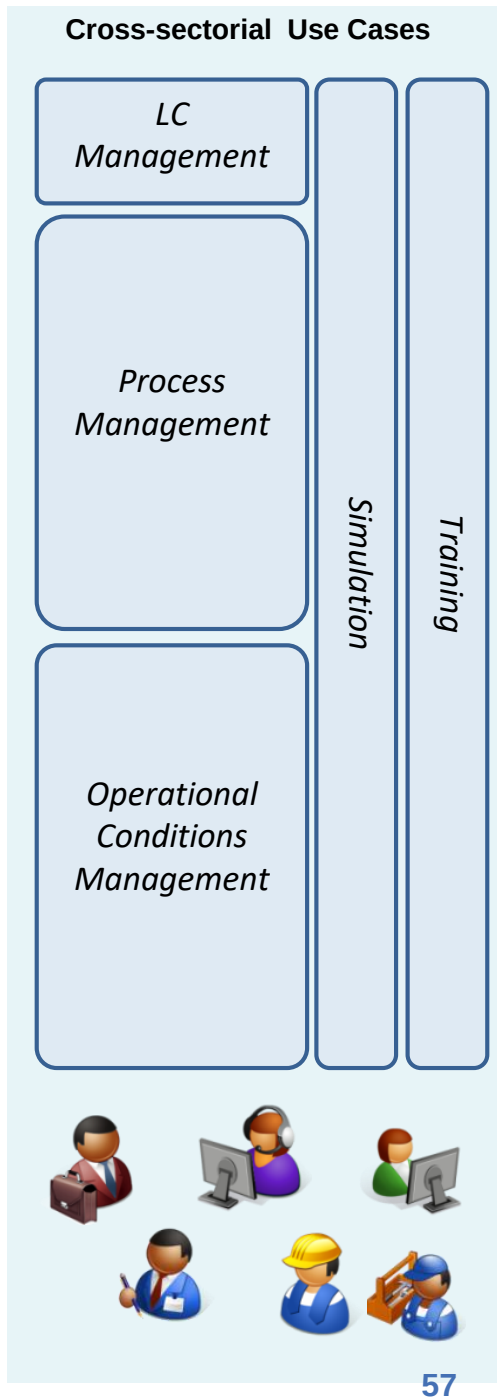
A novel **model based development environment** – **Cross-Sectorial Data Lab** – to facilitate design, development, integration, deployment and testing of **predictive control algorithms**

Symmetric plant and site-wide **Online Life Cycle Management Tools** (also entailing **circularity** aspects) **integrated** with the monitoring and control infrastructure

Demonstration and Evaluation of the proposed solution in the **Aluminium** and **Plastic Industry**

The MONSOON Reference Architecture





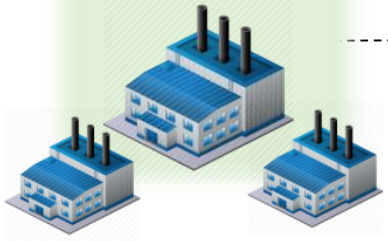
MONSOON enabled Vision

MONSOON Data Lab

*Cross-sectorial collaboration to **develop** data-driven Model Based **Predictive Functions***

*Hybrid off-line and on-line **evaluation** of model based Predictive Functions (development, iterative fine-tuning, etc.)*

*Scalable Real-time **Monitoring** of Data-Intensive Processes from Multiple Production Sites*



Orient

Observe

Decide

Act

Dynamic Multi Scale Cross-sectorial Process Industry Models

*Impact prediction, Feasibility **Assessment***

*Impact **Evaluation**, LC **Assessment***

*Multi Scale Distributed Controls **Runtime** in the Factory*

*Rapid **Prototyping** and **Deployment** of Model Based Predictive Functions*

Cross-sectorial Use Cases

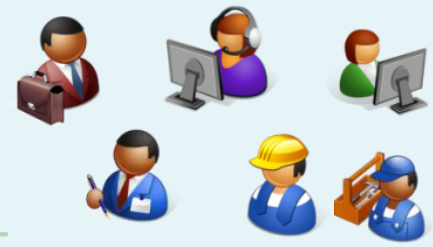
LC Management

Process Management

Operational Conditions Management

Simulation

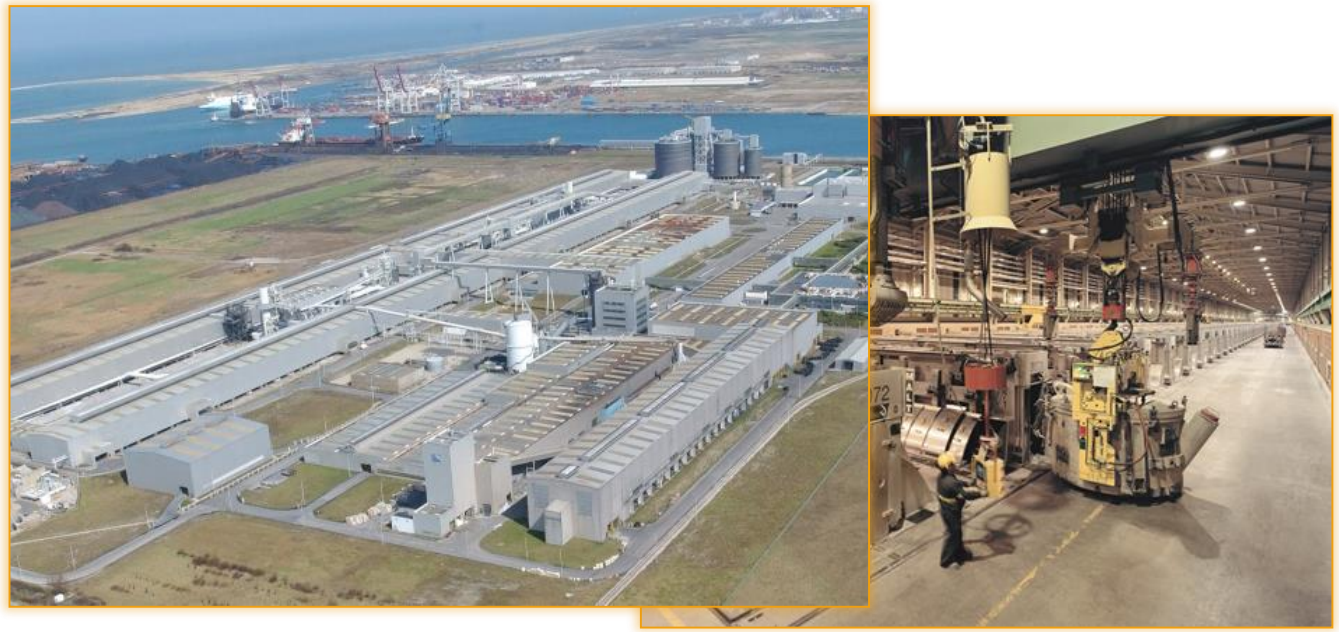
Training



MONSOON Application Domains

Aluminium

Primary Production



Dunkerque plant (FR)

Highest-producing primary aluminium plant in the EU-28 area (consumption 3.7 TWh of electricity - equivalent to a 1 million people city)

Plastics

Injection moulding

Maceira-Leiria plant (PT) – GLN

Injection moulding machines

ALUMINIUM USE CASE

Green Anode Production

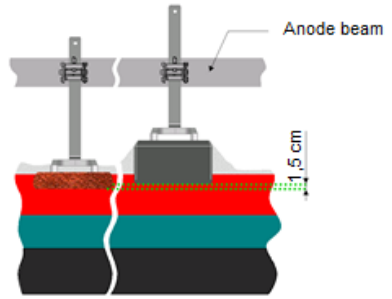
- **Prediction of Anode Quality**
  - **detect bad anodes** with high level of confidence and avoid forwarding them to the electrolysis area
  - **predict** non conformant production (global or individual anomalies) and **trigger** relevant actions to correct the problem

Anode non-quality can lead to non-homogeneous and reactive anodes

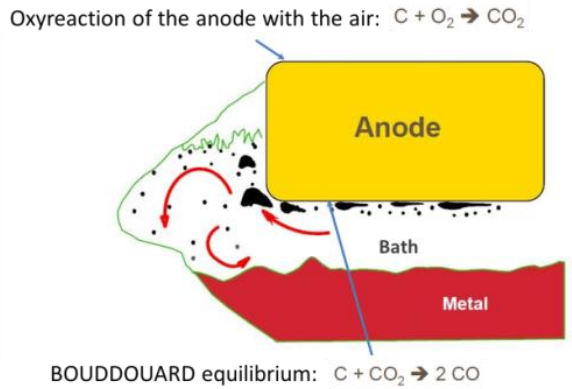
- *Dusting in pots*
- *Reduced lifecycle on pots (more frequent anode change)*
- *Incidents on pots like mushrooms (spikes), flatness defect (deformation)*
- *CO_2 emissions due to the anode overconsumption*

Mushrooms or spikes

Anode flatness defect



Net carbon and anode consumption



Anode reactivity

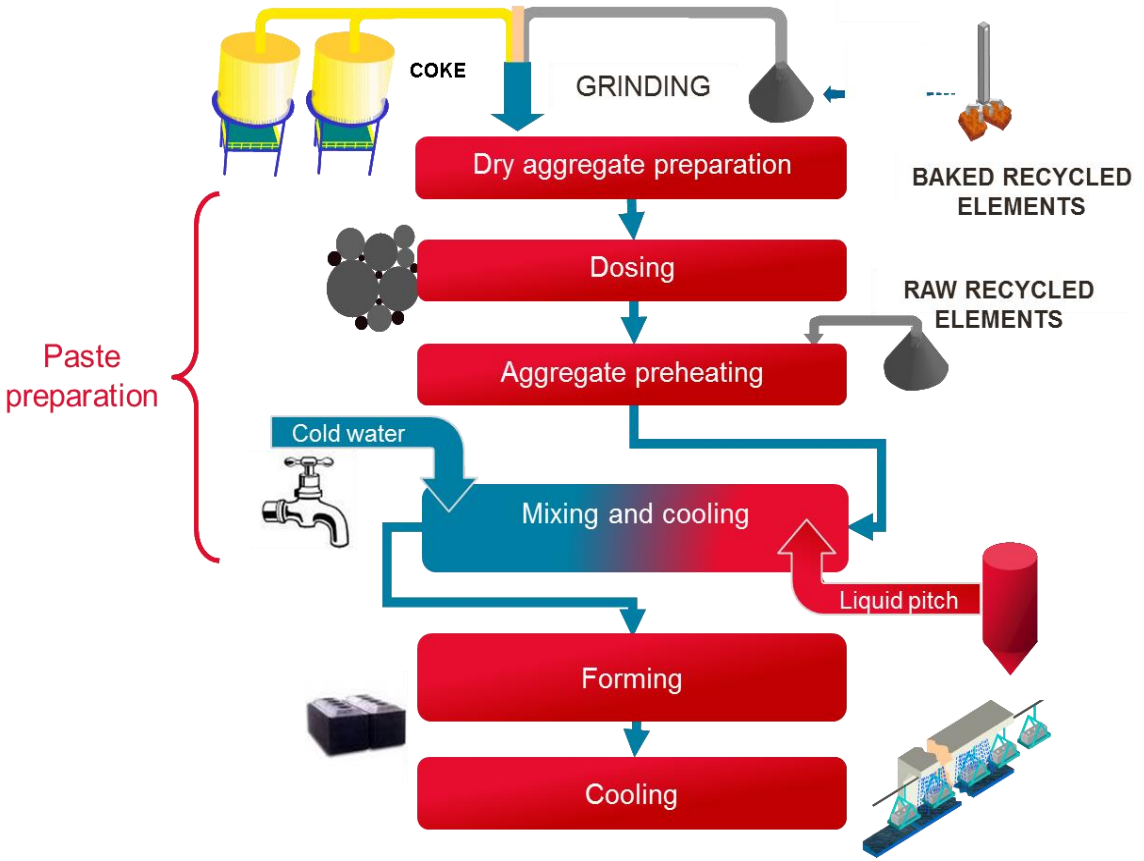
Green Anode Production

- **Predictive Maintenance**
  - **prediction** of paste plant stoppages and equipment deviation
  - Identification of **correlation** between equipment deviations and stoppagies and decrease of anode quality to **trigger** relevant actions and predictive maintenance operations

Monitoring of equipment most impacting on anode production

- ***Paste mixer**: machine to prepare the paste*
- ***Paste cooler**: machine to cool down the paste before the forming step*

Results could be used as a basis for the predictive quality enhancements



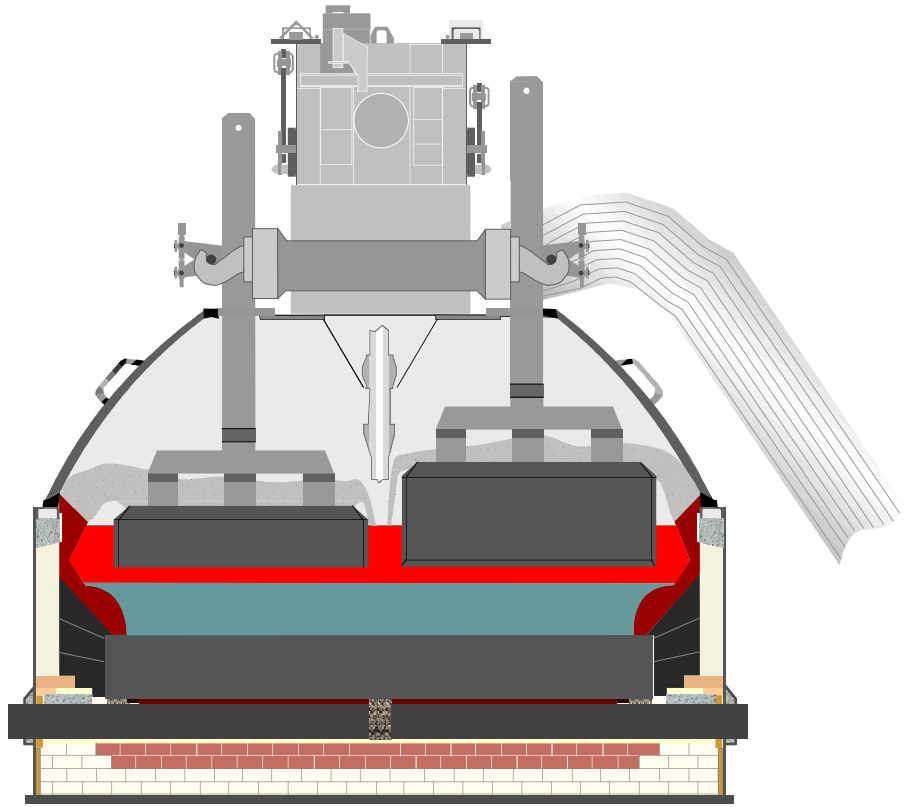
Electrolysis Area

- **Predict in real-time the liquid heights (bath and metal)**
- **Predict in real-time the thermal balance**

These two variables have a great impact on the pot performances that are the optimized energy consumption and current efficiency.

Objectives:

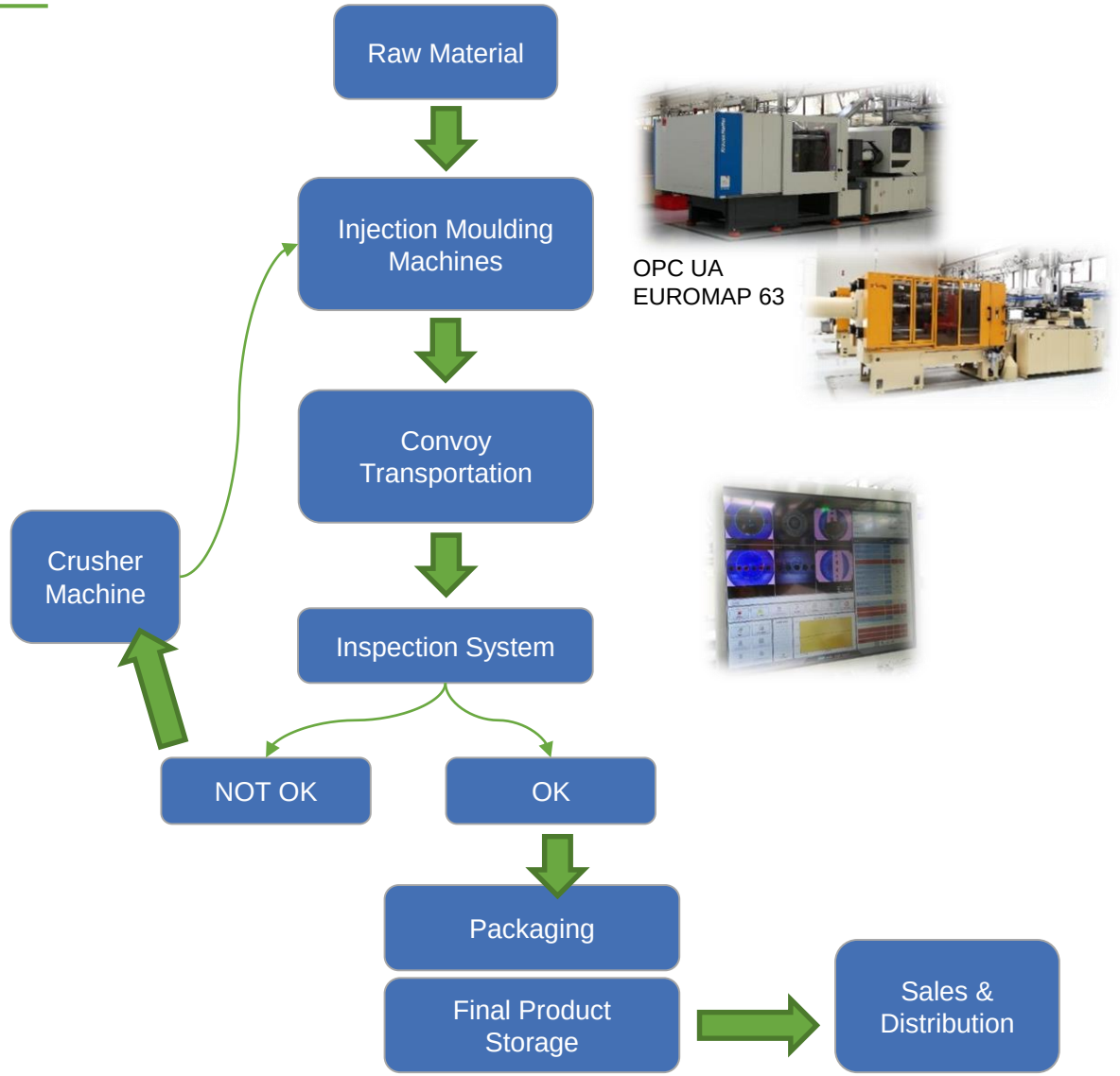
- *Give* **indications** *on the appropriate operations to be done on the pot (adjustments of the bath volume, volume of metal to be tapped…)*
- *Give* **optimal parameter settings** *based on process expertise*
- *Anticipate process deviations via* **predictive alerts** *and* **take countermeasures** *(e.g. adjust parameters settings) to improve pot stability.*



PLASTIC USE CASE

Injection Moulding – Coffee capsules

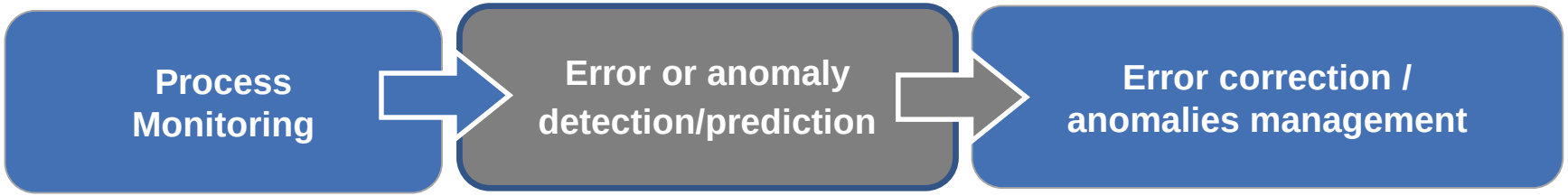
- *Polypropylene coffee cups and respective lid - being produced*
  - in large quantities (400.000 units produced per machine/day)
  - with a fixed product flow and small variations
  - with a high production rate
  - using 32 cavity moulds, 6,5 – 7 sec cycle



Injection Moulding

- *Objectives*
  - *to **reduce production stoppages** and*
  - ***decrease** the **waste** of raw material (mainly caused by height deviation from nominal values in produced capsules)*

- Considered steps
  - **Exploit** the data coming from the injection moulding machines, possible additional sensors and from the ***inspection system*** (*properly updated to collect information useful for predictions*)
  - **predict** equipment/process **deviations** that impact the quality of manufactured capsules
  - **predict capsules quality** as binary classification (high/low quality)
  - **trigger** relevant actions to correct the problems

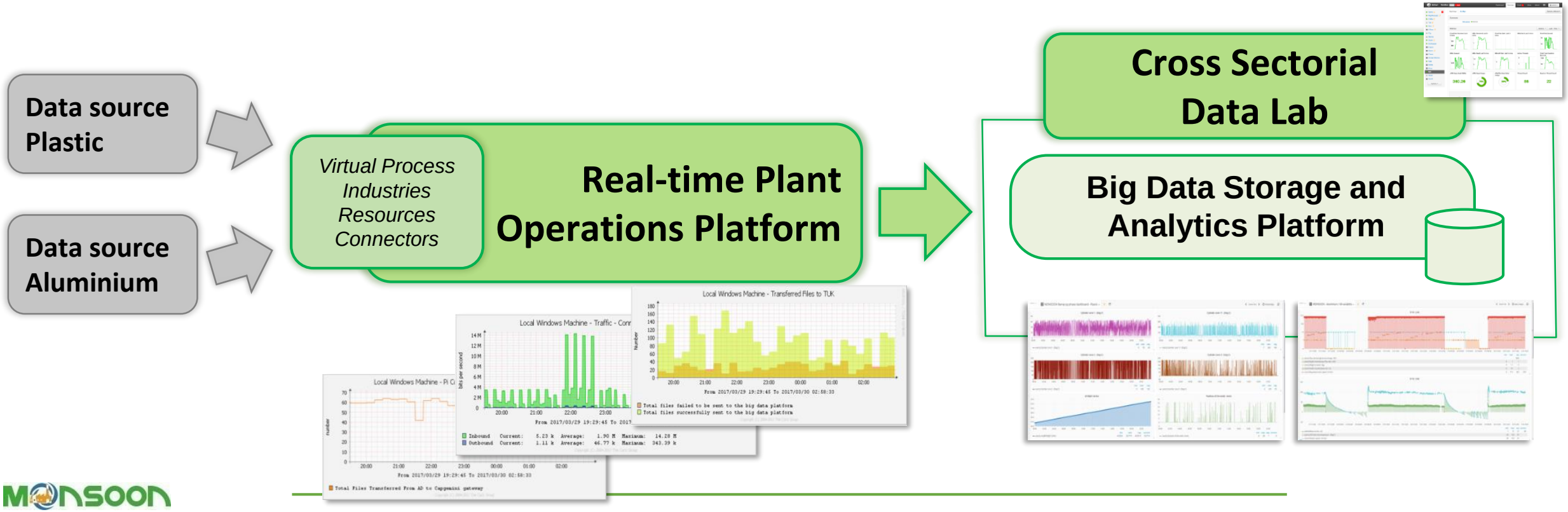


FIRST ACHIEVEMENTS

Ramp up phase

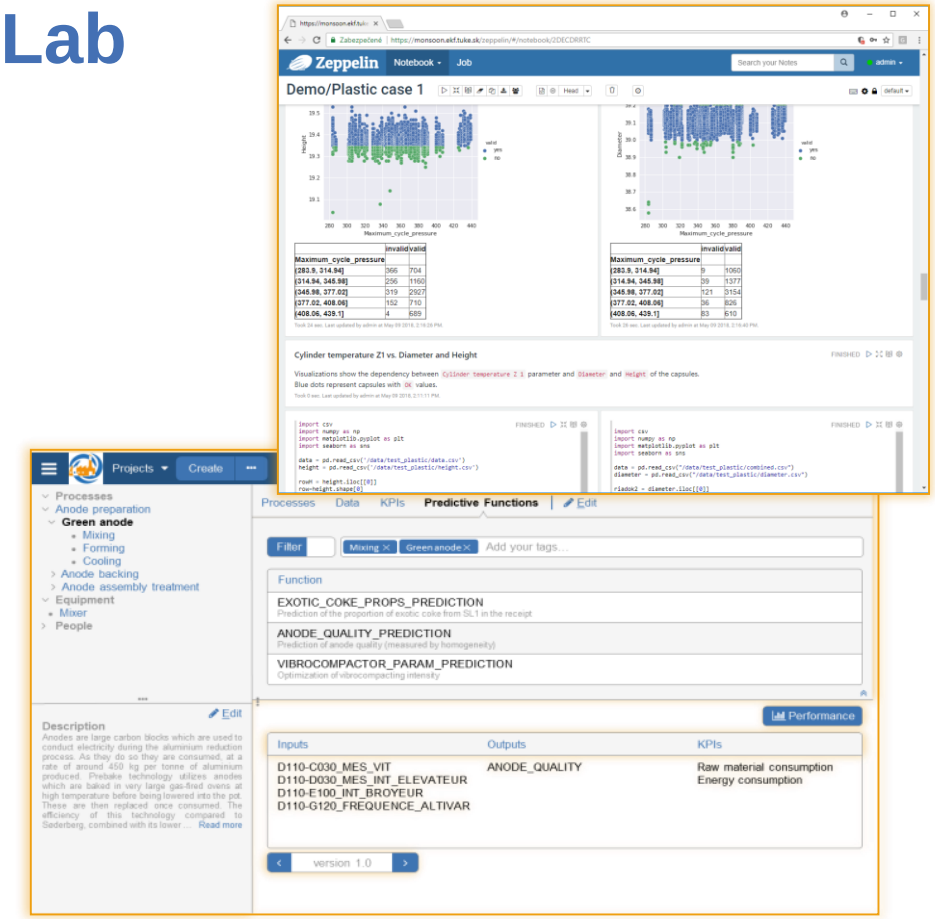
****** Data driven approach ******

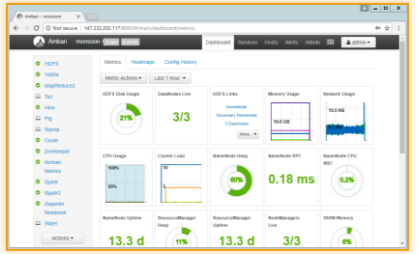
- MONSOON **Data Collection** and **Monitoring infrastructure** installed in real environment, also supporting interoperability between heterogeneous plant systems, sensors and actuators
- Initial **Cross Sectorial Data Lab** – big data storage and analytics platform and GUIs presenting observed data



Cross Sectorial Data Lab

- First release of the **Big Data Storage and Analytics Platform**, adopting and extending **open source solutions**
  - KairosDB (time series query engine), Cassandra (distributed database) and Grafana
  - Python tools for **data analytics** (SciKit learn, Xgboost, LIME, …)
  - Apache Zeppelin – **collaborative development environment** customized and extended for Docker environment, i.e. scripts edited in Zeppelin are running in Docker container connected to Big Data storage
- **Semantic Framework** to simplify communication between the domain experts and data scientists across different domains.





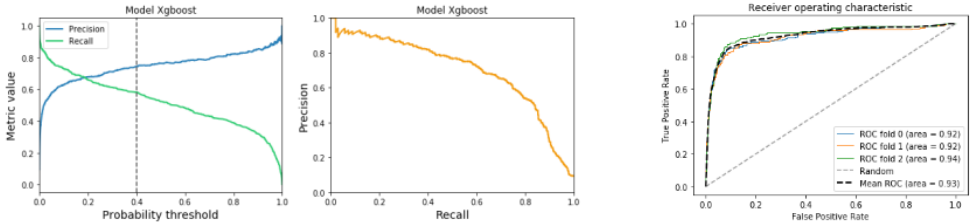
- 1x server 16 logical CPU cores, 84 GB operating memory, 450 GB local drive mapped to the host physical drive
- 7.6 TB network attached drive
- 1x 1Gbps virtual network interface (VNIS)

Online and deep machine learning solutions

Anode quality

- A machine learning **model** classifies 30 minutes periods of anode production as **high** or **low quality**, using only **process data** (51 variables)

*- Identification (with the help of process experts) of possible new **causes** of abnormal anode quality and relevant **actions** to correct/mitigate the issues*



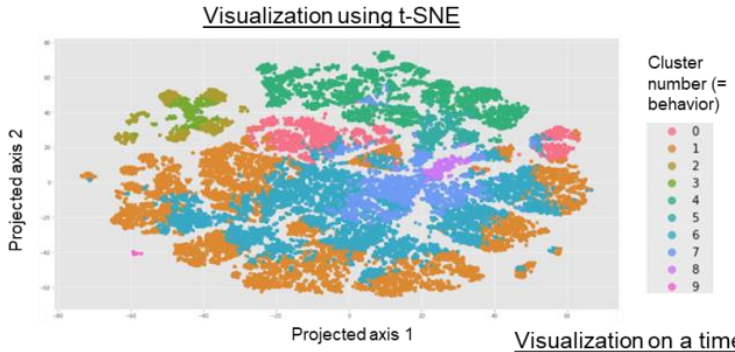
The model has been deployed and connected to real data flow

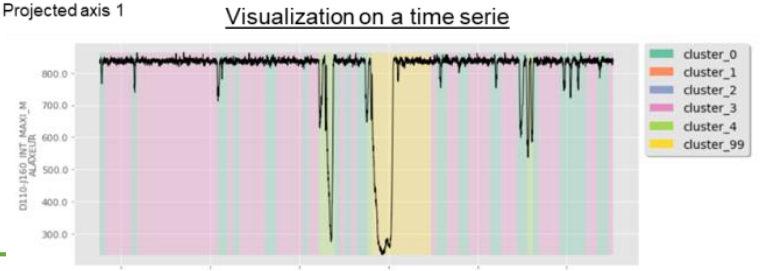
Anomalies in the paste plant

- Unsupervised machine learning techniques (**clustering**) have been used to identify the different **behaviours** of the paste plant equipment

- Preliminary analysis for BUSS mixer proved to be valuable

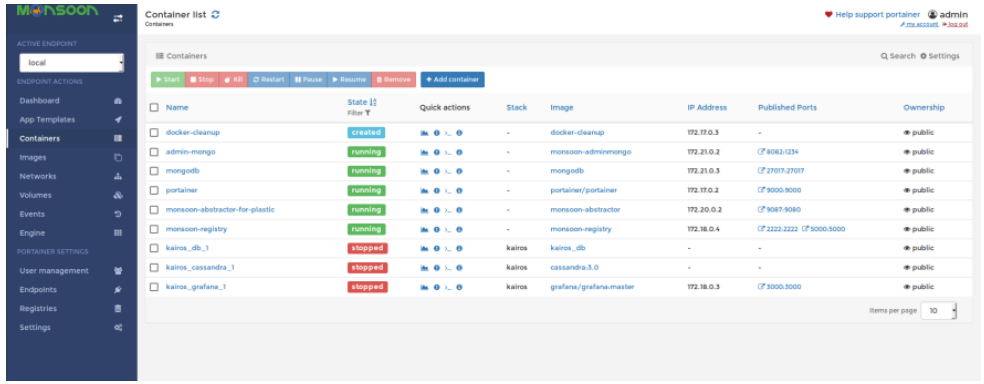
Insights about several BUSS mixer behaviours





Enabling easier and faster deployment to the field

- **Runtime Container** – ICT infrastructure (*based on Docker technology*) supporting more easily and quickly deployment to the real environment of **predictive control functions** and **LifeCycle (LC) calculations** designed, developed and tested in the **Cross-Sectorial Data Lab** (MONSOON model based development environment)
  - **Executes** at **runtime** model based predictive control functions and LC online calculations
  - Ensures proper deployment, execution and **access** to relevant **industry resources**, **data** from sensors, actuators and sub-systems
  - **Manages** the **life cycle** of predictive control functions and LC online calculations
  - Provides **data visualization solutions** and **dashboards** embedded on the Plant Platform, also displaying predictive alerts



additional results are still to come!!

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DIGITIZED OPERATIONS for SUSTAINABLE PROCESS INDUSTRIES

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REGISTRATION REQUIRED!!

DECHEMA - Frankfurt am Main, Germany

18 October 2018, 9:30 – 20:00

Participation of A.SPIRE, EFFRA and EC DG Research and Innovation

MONSOON

MOdel based coNtrol framework for Site-wide OptimizatiON of data-intensive processes

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SPIRE

Sustainable Process Industry through Resource and Energy Efficiency

Moderator: Prof. Dr. Sebastian Engell

Roberto Cascella, ECSO

Senior Policy Officer at European Cyber Security Organisation

Ana García Robles

Big Data Value Association Secretary General

Harri Kulmala

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