ENABLING PERSONALISED PRODUCTION WITH INTELLIGENT MANUFACTURING ENVIRONMENTS

GIL GONÇALVES, UNIVERSITY OF PORTO, PORTUGAL

INTELLI 2017
JULY 23 - 27, 2017 - NICE, FRANCE

SYSTEC | RESEARCH CENTER FOR SYSTEMS & TECHNOLOGIES

Smart search...

A60W

SELSUS - INDUSTRIA 4.0

SelSus
MANUFACTURING SYSTEMS

NHOC2017

SYSTEC

SYSTEC is a research unit hosted at FEUP and ISR and promotes: (i) academic excellence, (ii) worldwide networking with institutions and researchers with opportune scientific affinities to ensure the critical mass, (iii) interaction with end-users and stakeholders to promote the tuning with challenge-driven innovation dynamics, and (iv) integration with advanced formation activities.

SYSTEC addresses real world challenges by articulating theoretical and applied research in 4 Thematic Lines:

SYSTEC–CONTROL: Systems, Control, Optimization, and Estimation Technologies

SYSTEC-NET: Networked Robotic Vehicles and Systems Technologies

SYSTEC-ENERGY: Smart Energy Systems and Technologies

SYSTEC-MANUFACTURING: Smart components for Advanced Manufacturing Systems and Technologies

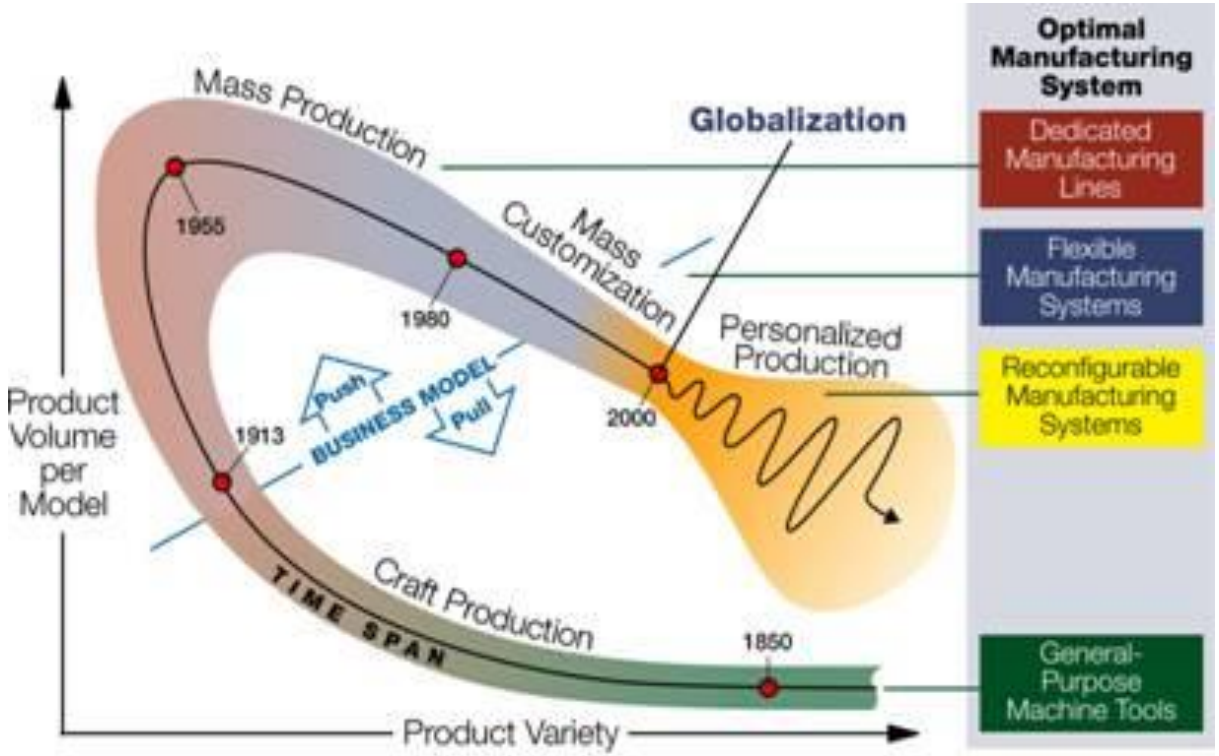
SYSTEC-MANUFACTURING

Design, implement and validate **smart components for advanced manufacturing system** aiming to **introduce intelligence into industrial processes** and contribute to the emergence of the intelligent manufacturing environments of the future, by implementing novel approaches into **Cyber-Physical Production Systems**.

Motivation

FROM CRAFT PRODUCTION TO PERSONALISED PRODUCTION

From craft production to personalised production



TRENDS

Customer specific production:

- Individualised products
- Mass production but individual design
- Small lot sizes, one piece flow

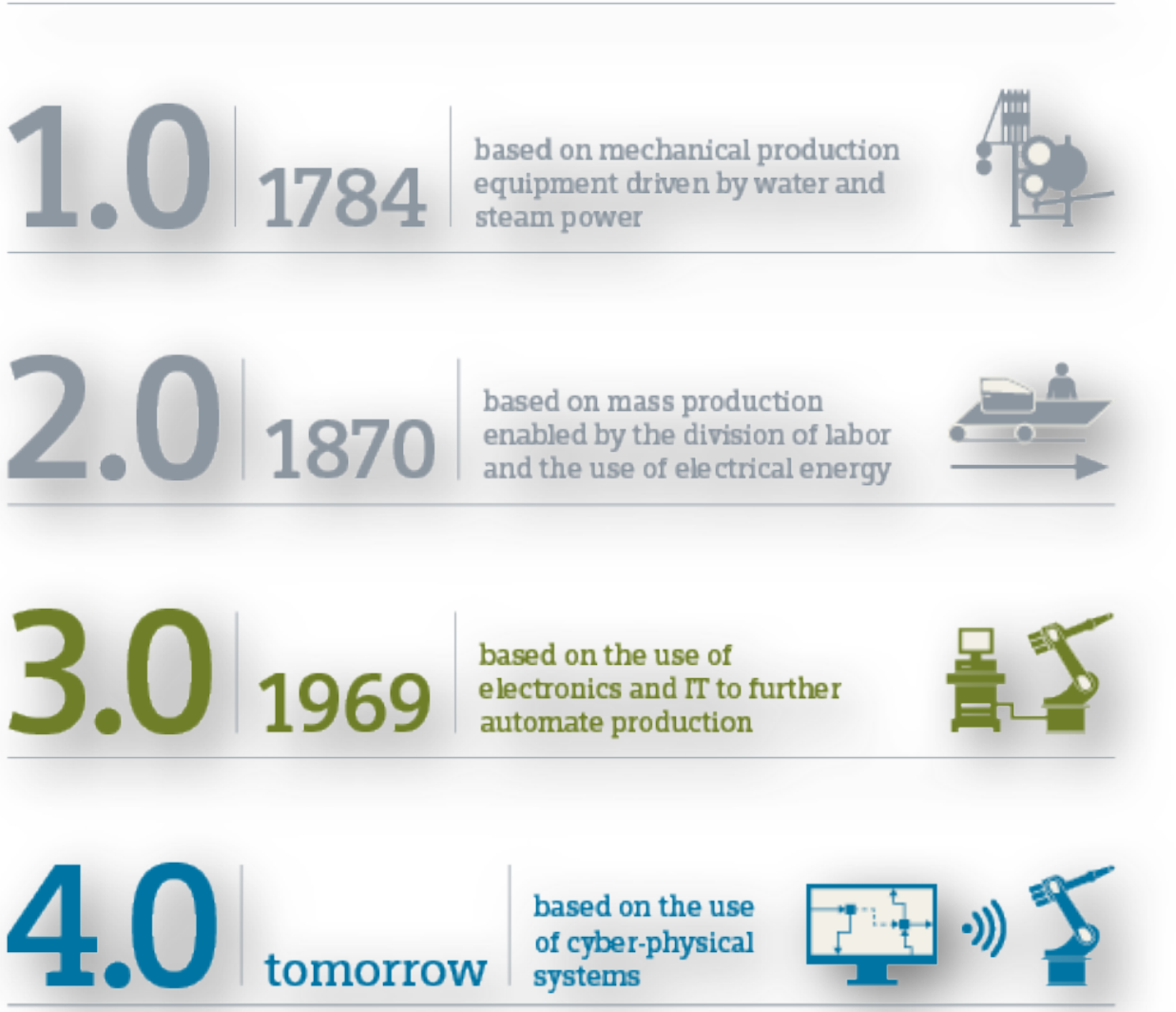
Sustainability:

- High efficiency and near-to-zero emission
- Reusability of machines and equipment
- Avoid waste

Digitisation and networking:

- Digital & virtual factory
- Integrated value chains
- Constant change

Industry 4.0



Technology:

- Digital networking production facilities
- Fast pace of technological change and innovative technologies

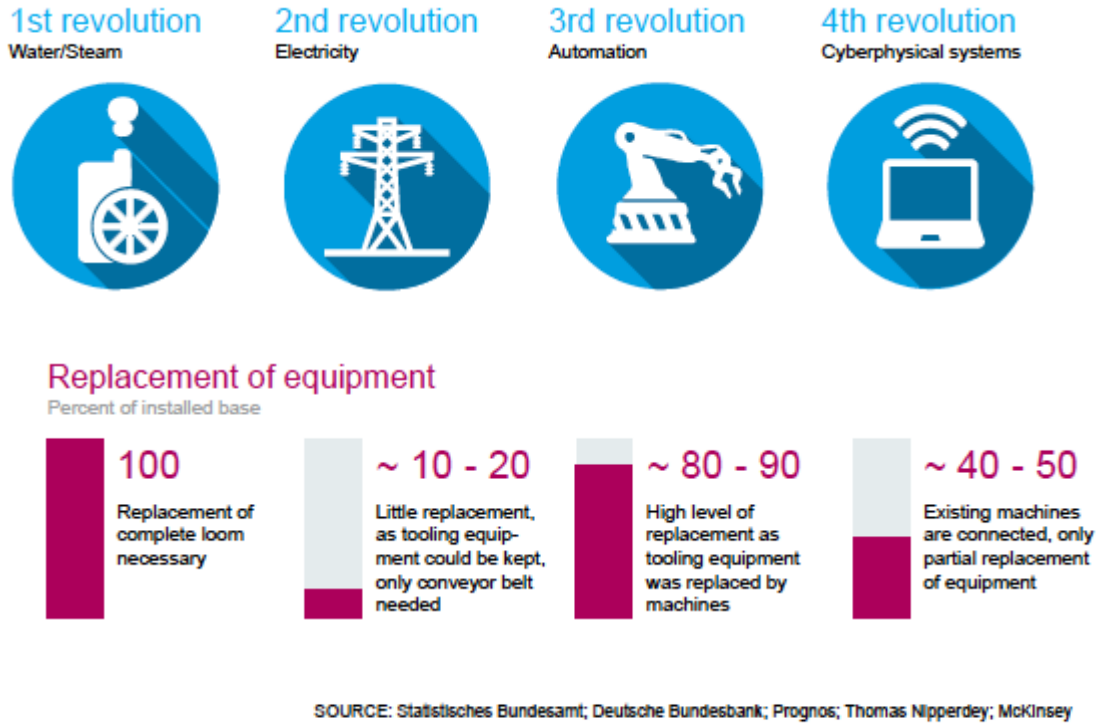
Customers:

- Customised solutions
- Wide diversity of customers and markets
- New services

People:

- Demographic development
- Training and qualifications
- Interaction between human beings and technology

What's so different about industry 4.0?



- It's not about replacing the existing assets
- It's about mastering disruptive technologies along three dimensions:

1. Operational effectiveness
2. New business models
3. Digital transformation of the company

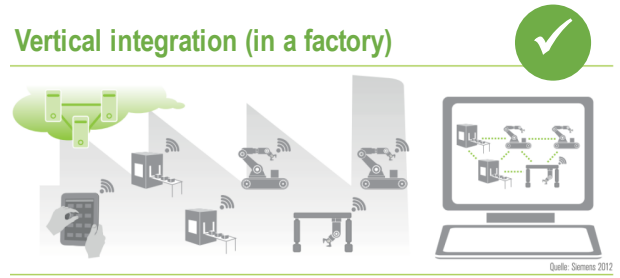
Towards Personalised Production

INTELLIGENT MANUFACTURING ENVIRONMENTS

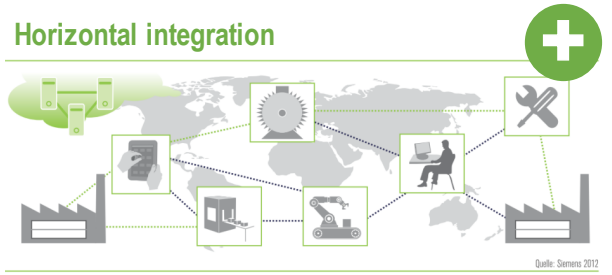
Intelligent Manufacturing Environments

Digitisation and networking

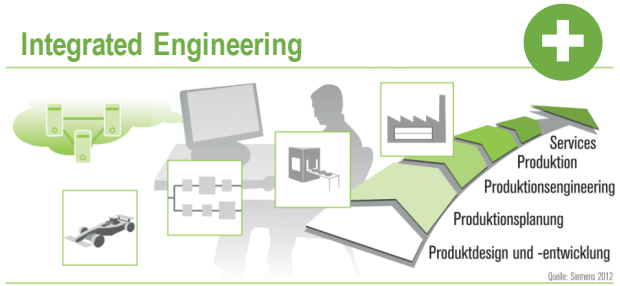
- Vertical integration of hierarchical subsystems leads to smarter factories
- Supports horizontal integration through value networks
- End-to-end digital integration of engineering.
- Based on this global collaboration network, the consumers, design activities, manufacturing, and logistics can interact above the cloud



Reconfiguration • Lot size 1 • Apps • Constant change



Value chain • Life cycle costs • Customized products

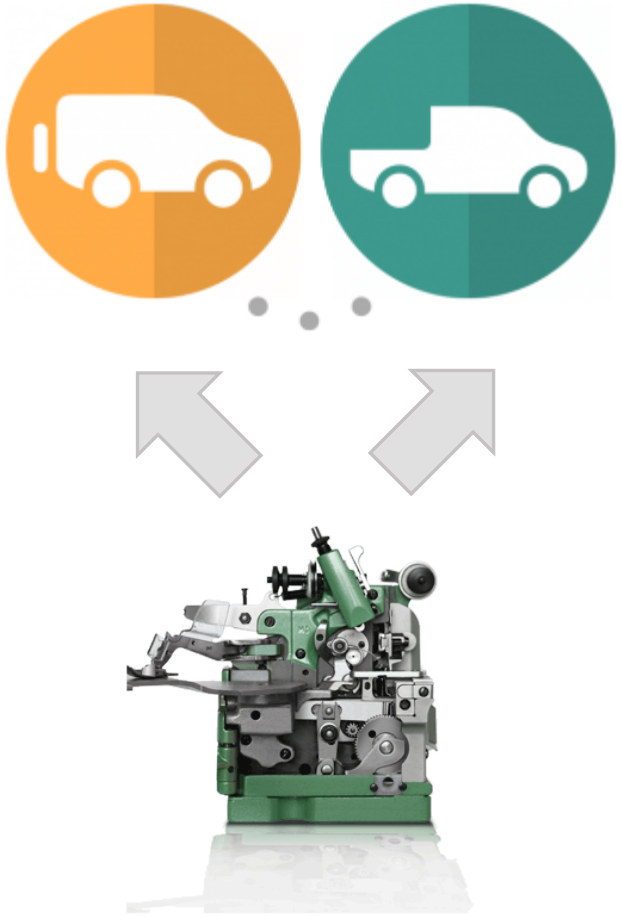


Systems Eng. • along supply chain • Dig. factory

Intelligent Manufacturing Environments

Small lot sizes, one piece flow

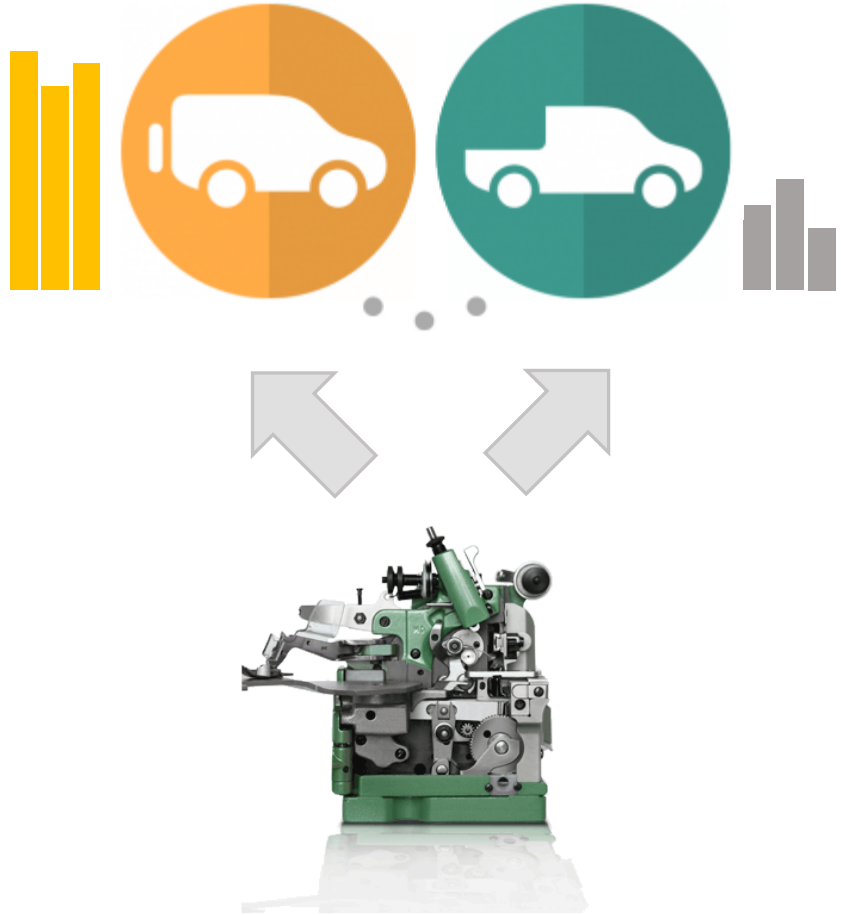
- Equipment can be reconfigured automatically to produce multiple types of products
- New products can be directly ordered to the system, helping to cope with ever changing market and discerning consumption demands
- The self-organization and dynamic reconfiguration allows new machines to join the system in a plug 'n' produce fashion
- Malfunction machines will not affect the system due to the machine redundancy



Intelligent Manufacturing Environments

Customer specific production

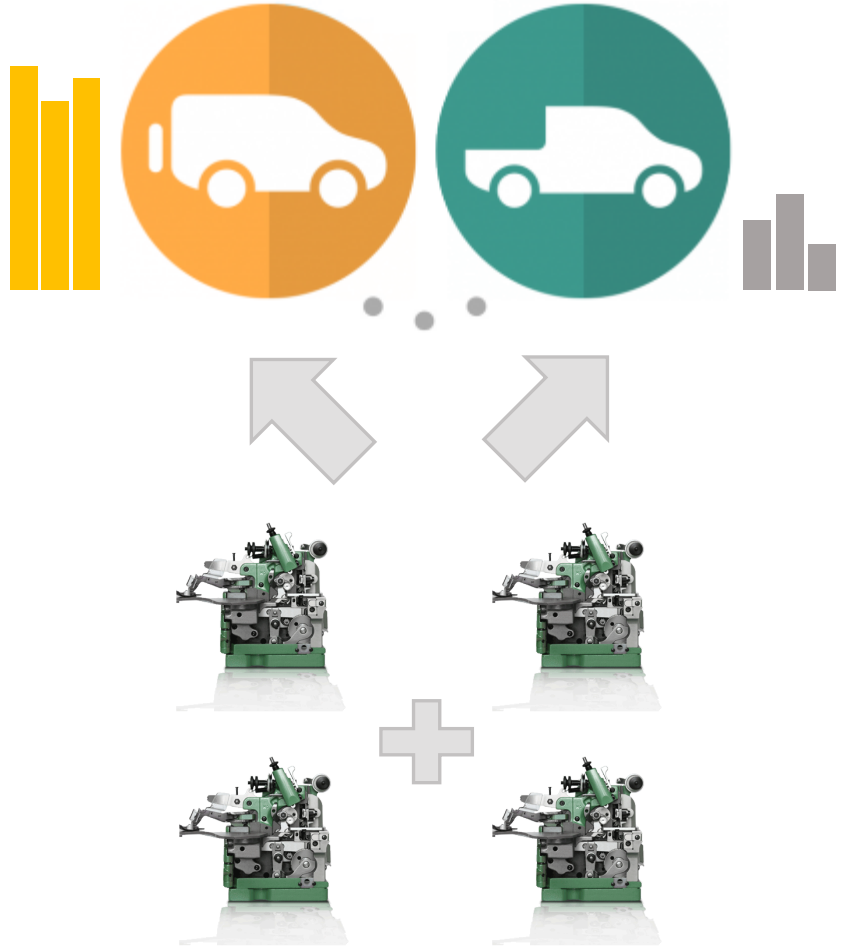
- Equipment can be reconfigured automatically to produce multiple types of products
- New products can be directly ordered to the system, helping to cope with ever changing market and discerning consumption demands
- The self-organization and dynamic reconfiguration allows new machines to join the system in a plug ’n’ produce fashion
- Malfunction machines will not affect the system due to the machine redundancy



Intelligent Manufacturing Environments

plug ’n’ produce

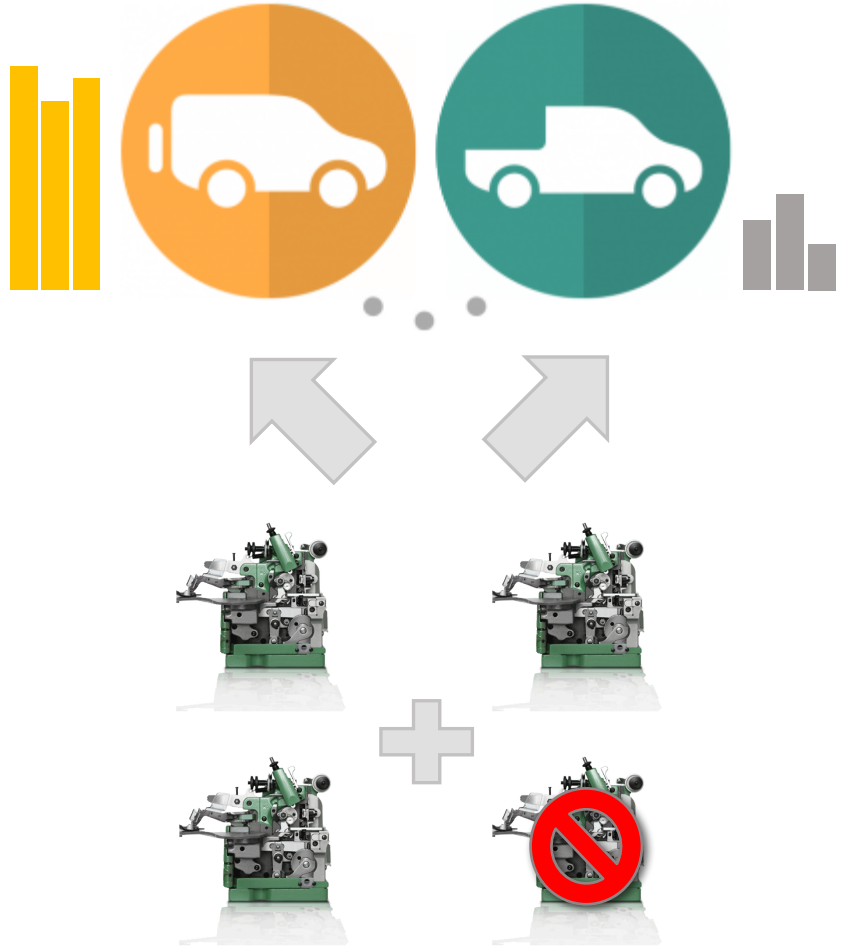
- Equipment can be reconfigured automatically to produce multiple types of products
- New products can be directly ordered to the system, helping to cope with ever changing market and discerning consumption demands
- Self-organization and dynamic reconfiguration allows new machines to join the system in a plug ’n’ produce fashion
- Malfunction machines will not affect the system due to the machine redundancy



Intelligent Manufacturing Environments

Fault tolerant

- Equipment can be reconfigured automatically to produce multiple types of products
- New products can be directly ordered to the system, helping to cope with ever changing market and discerning consumption demands
- Self-organization and dynamic reconfiguration allows new machines to join the system in a plug ’n’ produce fashion
- Malfunction machines will not affect the system due to the machine redundancy



Intelligent Manufacturing Environments

Sustainability

- Big data analytics, we can establish an accurate knowledge of production process and guarantee systems with a stable product quality and volume of finished products
- Needed raw materials can be determined before production and product redundancy can be minimized
- Equipment operate in more intelligent way, hence, the energy consumption can be optimized and reduced

Intelligent Manufacturing Environments

Avoid waste

- Big data analytics, we can establish an accurate knowledge of production process and guarantee systems with a stable product quality and volume of finished products
- Needed raw materials can be determined before production and product redundancy can be minimized
- Equipment operate in more intelligent way, hence, the energy consumption can be optimized and reduced

Intelligent Manufacturing Environments

High efficiency and near-to-zero emission

- Big data analytics, we can establish an accurate knowledge of production process and guarantee systems with a stable product quality and volume of finished products
- Needed raw materials can be determined before production and product redundancy can be minimized
- Equipment operate in more intelligent way, hence, the energy consumption can be optimized and reduced

Intelligent Manufacturing Environments

- Advanced Manufacturing Systems can produce small-lot products efficiently
- Setup time is minimized when switching between different types of products
- Production process is optimized with the help of big data
- Average manufacturing routes are shrunk
- Utilization rate of machines and other resources is improved

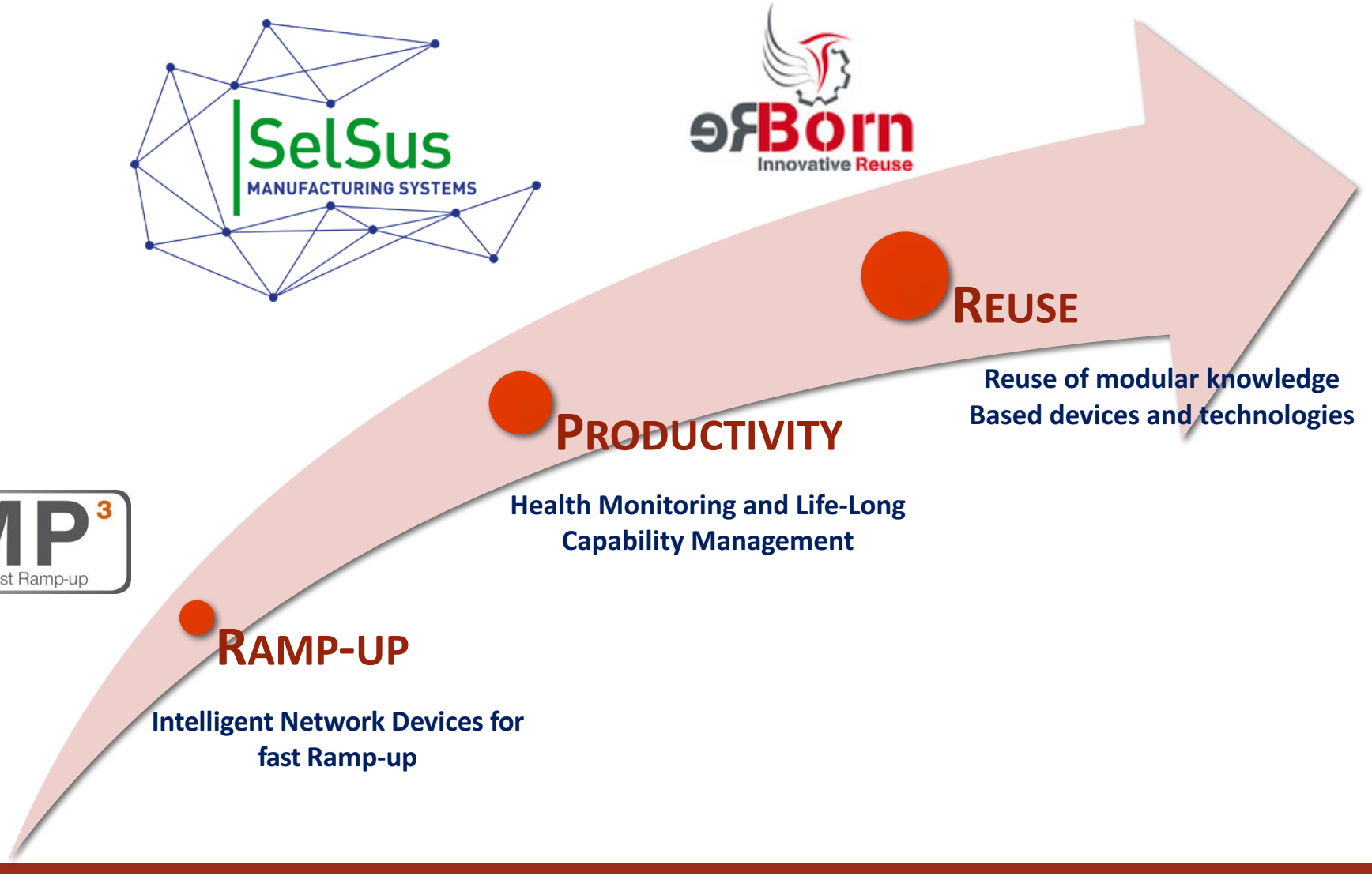
"Any customer can have a car painted any color that he wants so long as it is black."

Henry Ford

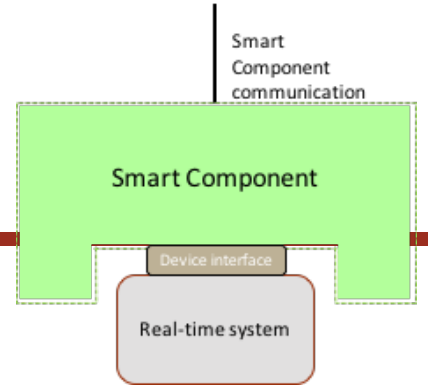
Enablers

R&D EFFORTS IN INTELLIGENT MANUFACTURING ENVIRONMENTS

Enablers of Personalise Production



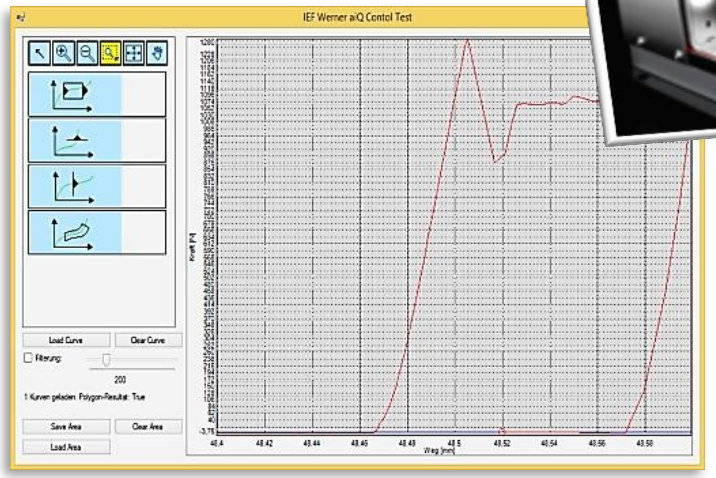
Smart Component



There are five essential characteristics to a Smart Component:

- Reconfigurable and modular - must be capable of extend its capabilities by adding new software modules and it must be capable of reconfigure it's internal operation in runtime.
- Data processing - system state assessment, event detection and fault alarm requires data processing capabilities.
- Communication and interface capabilities - capable to talk with lower level devices (sensors and machines), same level (other Smart Components) and higher level (cloud servers, MES).
- Process events and act - certain degree of smartness and autonomy; in case any event of interest, the system must be capable of detecting it and take the proper actions.
- Real-time data acquisition, processing and delivering - devices operate at variable (real)time scales, performing multiple tasks in a coordination.

Smart Component Servo press



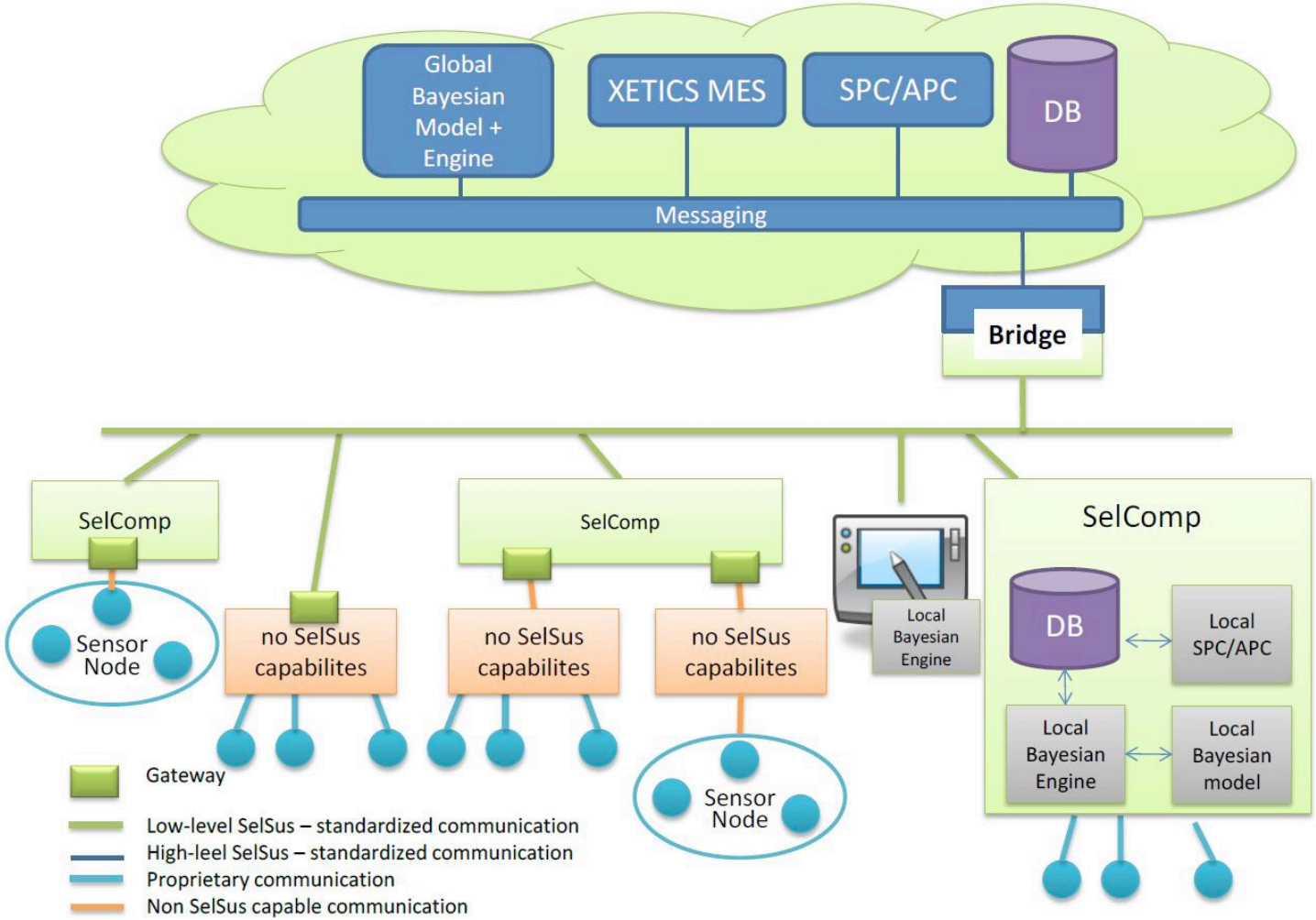
Ramp-up scenario:
Ramp-up after component/product exchange

Derived use-cases
#1 Servo press auto-configuration with recipe database
#2 Plug & produce sub-component exchange for fast re-configuration
#3 Automated rapid high-precision parameter finding and optimization for pressing job
#4 Drag & drop visualization authoring and fast integration of equipment and sensor data

Application areas:
High precision joining & pressing processes High-precision pick & place tasks

Functionalities:
- Auto-detection of equipment, tasks, parameters Self-descripting capabilities
- Parameter finding and optimization
- Connection with visualization elements via drag & drop

Overall architecture

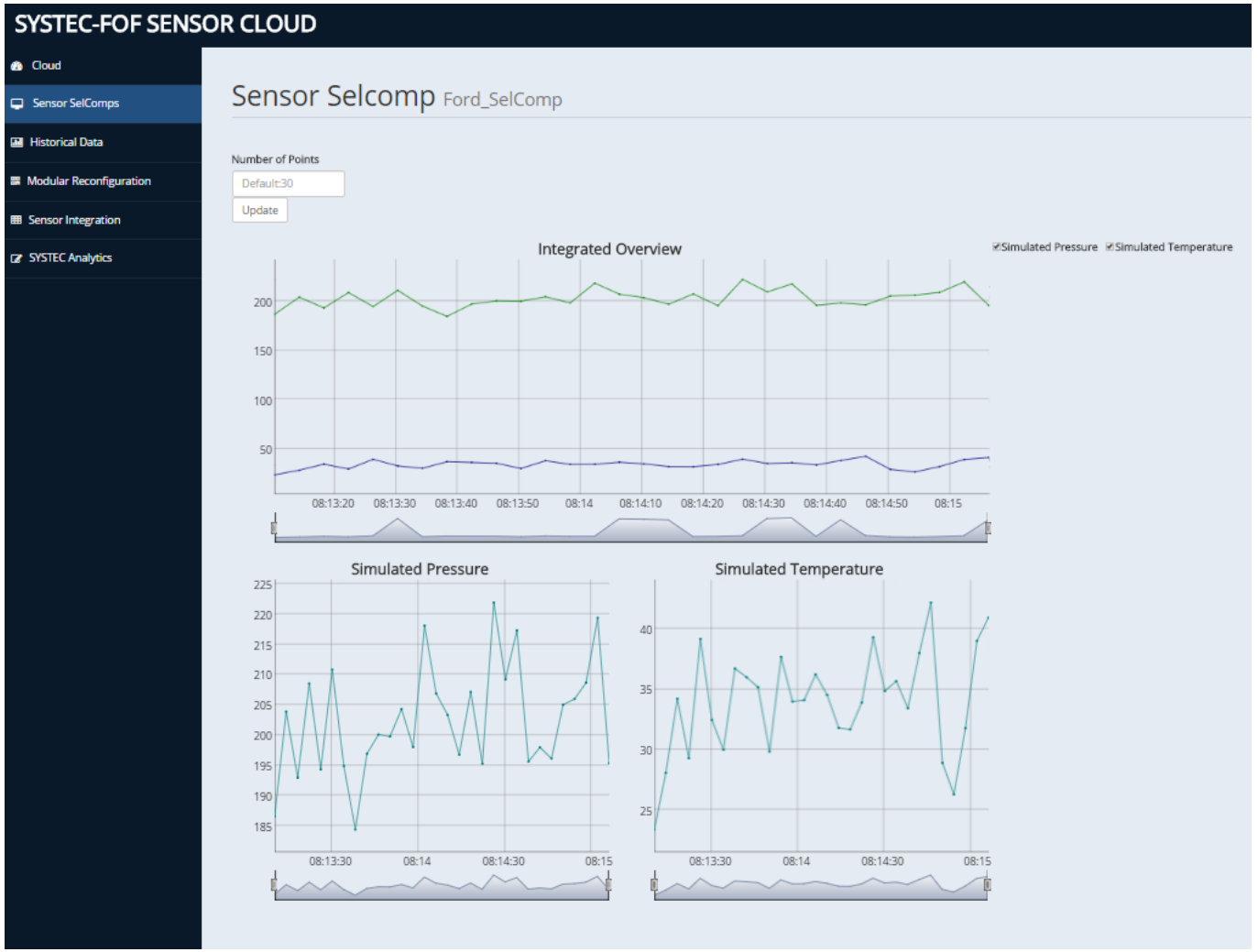


Smart Component Cloud

Cyber-Physical representation

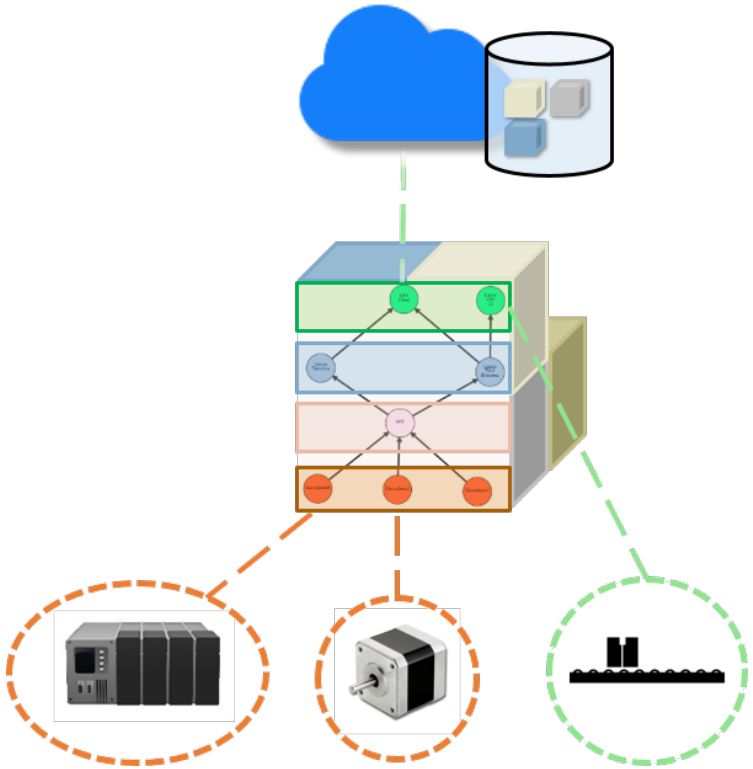
Inter-process communication

Advanced data processing

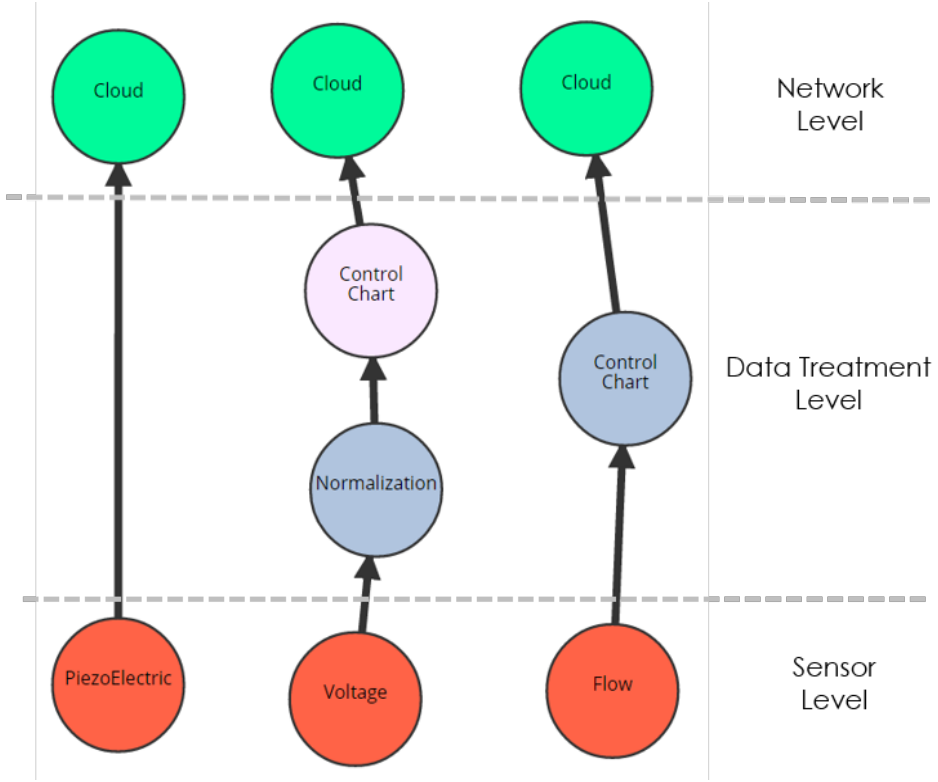


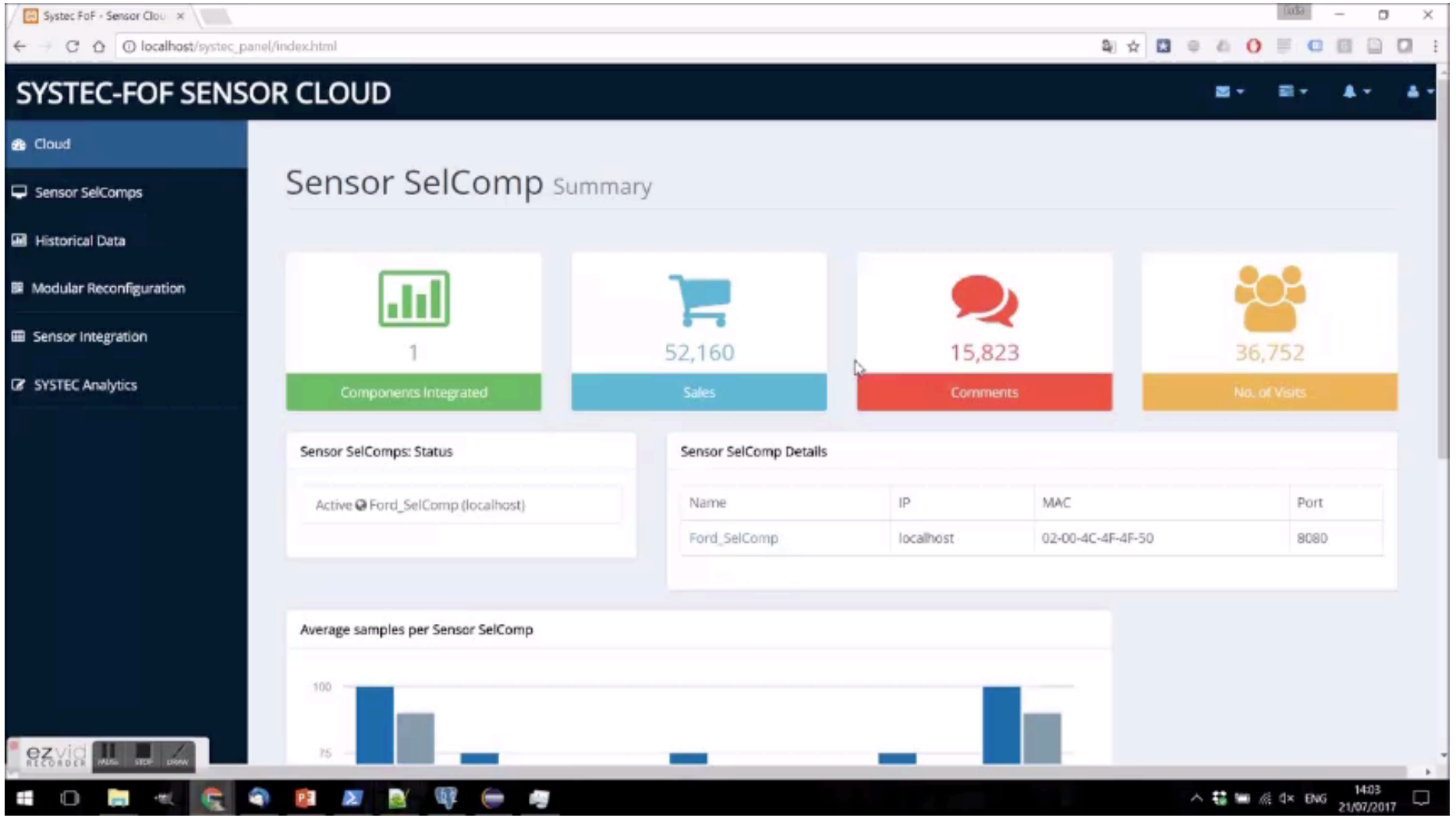
Dynamic modularity

Smart Component

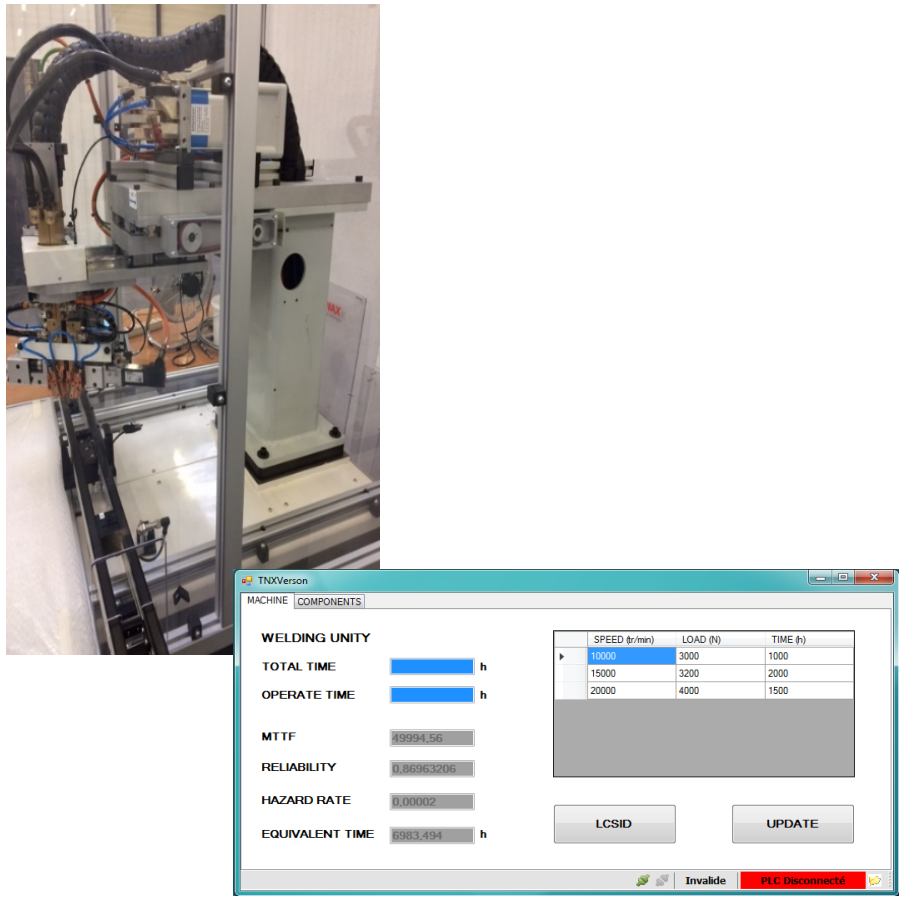


Dynamic Modular Software Reconfiguration (cloud)




Systec FoF - Sensor Clou
localhost/systec_panel/index.html
SYSTEC-FOF SENSOR CLOUD
Cloud
Sensor SelComps
Historical Data
Modular Reconfiguration
Sensor Integration
SYSTEC Analytics
Sensor SelComp Summary
1
Components Integrated
52,160
Sales
15,823
Comments
36,752
No. of Visits
Sensor SelComps: Status
Active Ford_SelComp (localhost)
Sensor SelComp Details
Name
IP
MAC
Port
Ford_SelComp
localhost
02-00-4C-4F-4F-50
8080
Average samples per Sensor SelComp
100
75
ENG
14:03
21/07/2017

Equipment awareness



With Smart Components equipment is capable of recording process data which can be analyzed and statistical information can be deduced.

Machine builders

- Instead of recycling an old machine or its components, machine builders evaluate the wear of old machine/components (with built-in software), modify it and re-use for new purposes. Evaluation takes a few minutes. **Saving of money can reach up to 50%.**

Plant owners

- Keeping brand-new components in stock is no more necessary. Components are chosen according to the needs. **Stock cost saving can reach 50%.**

New business model

- Equipment/components bought/sold through new modern e-commerce services such as market places. This enables new business opportunities for all partners.

Smart Component (prototype)

+

Production line construction and optimization

- With smart components, old equipment can be optimally used for dedicated purposes. Advantages:
  (1) Money for experts and new equipment's can be saved (~ 50% of price per equipment).
  (2) Line construction time can be reduced by ~ factor of 2 (all information is available within minutes).

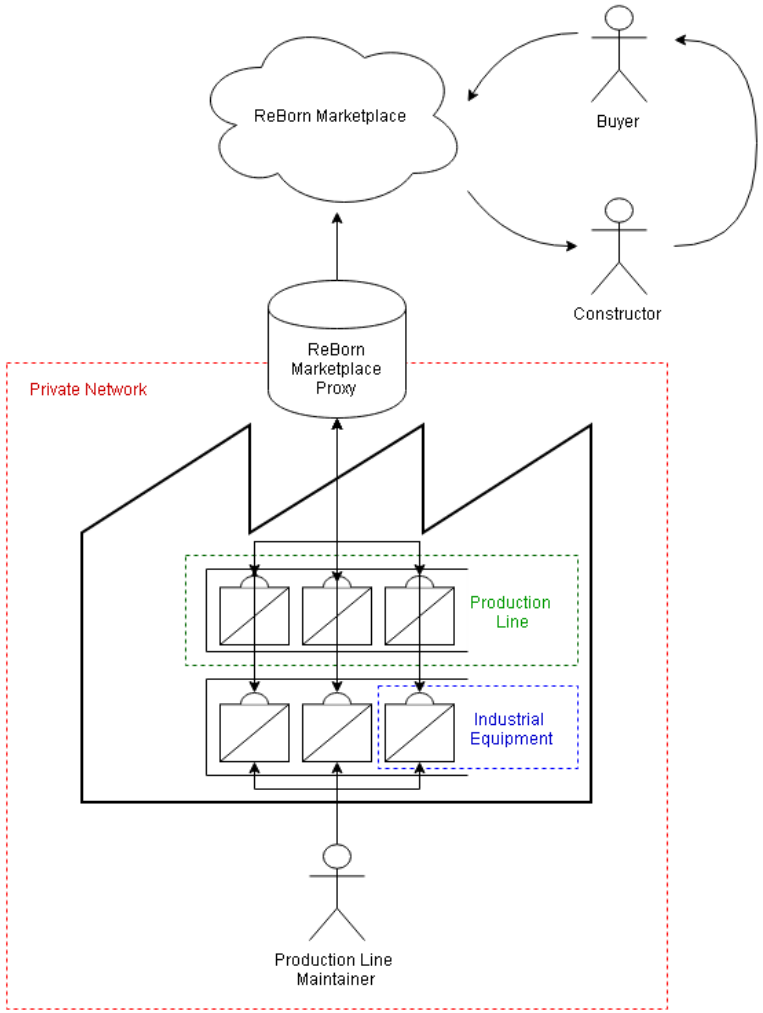
Degradation monitoring during the production

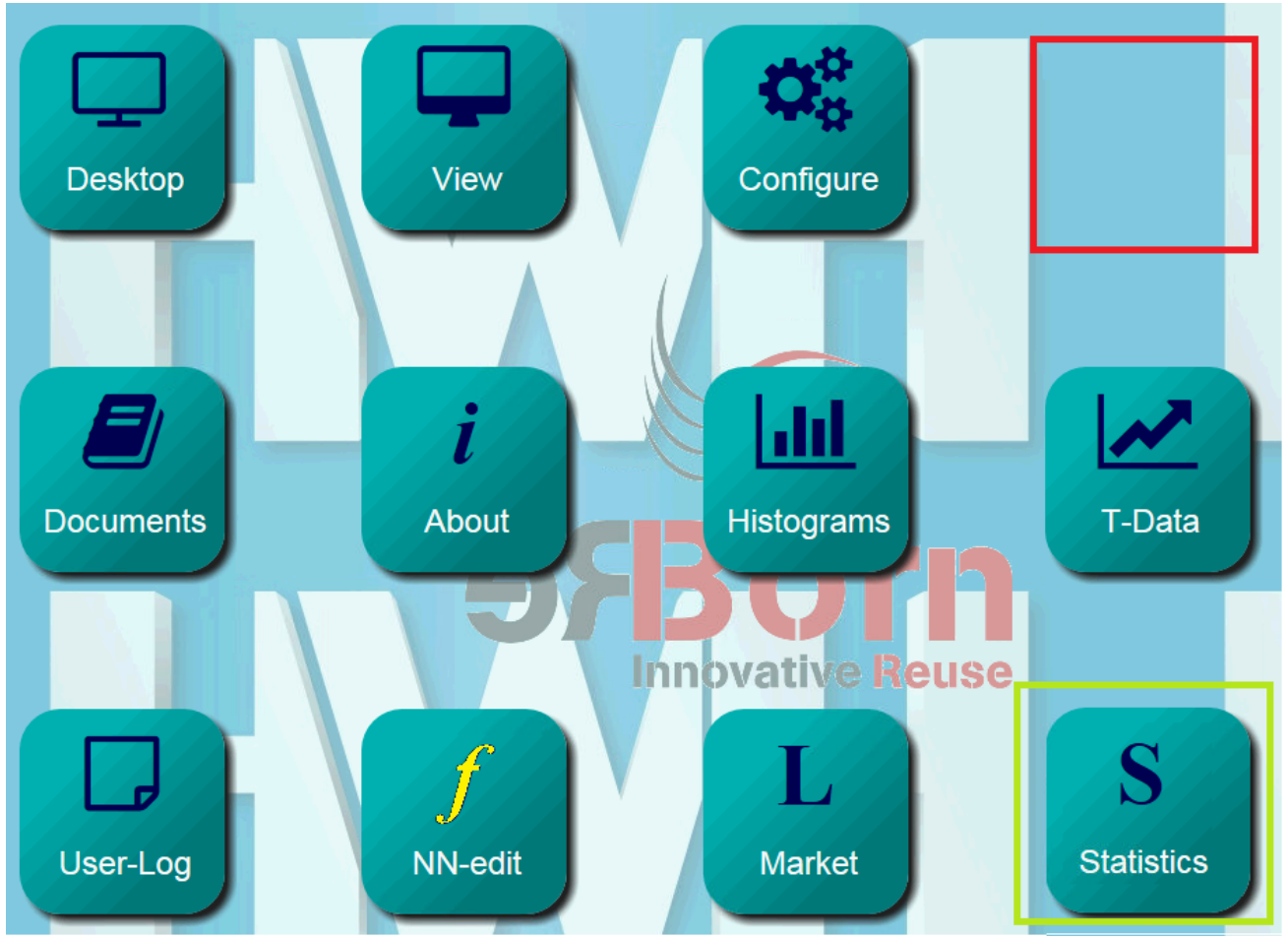
- Live monitoring of wear of components **is possible**. This allows to prevent failures and optimize maintenance, both lead to save of expenses. **Generation of use/ware information.**

Owner/Vendor sells smart component

- **Without smart component**: Owner has to remove equipment from production, store it, evaluate its price, contact Vendor, negotiate about price, wait for buyer.
- ***With smart component****:* Owner generates LCSID files and **sends** these **files to market place (< 1min).** Waits for a buyer without stopping the production. Gain of time/effort, and money can be drastically increased. This is new business model.

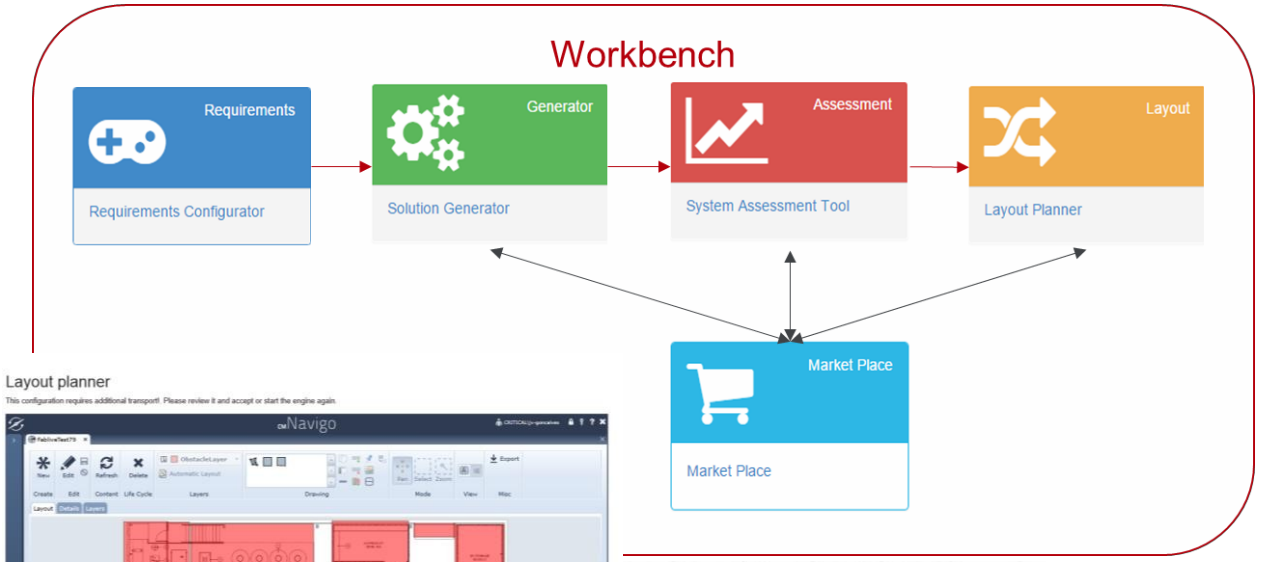
Line update (demonstrator)

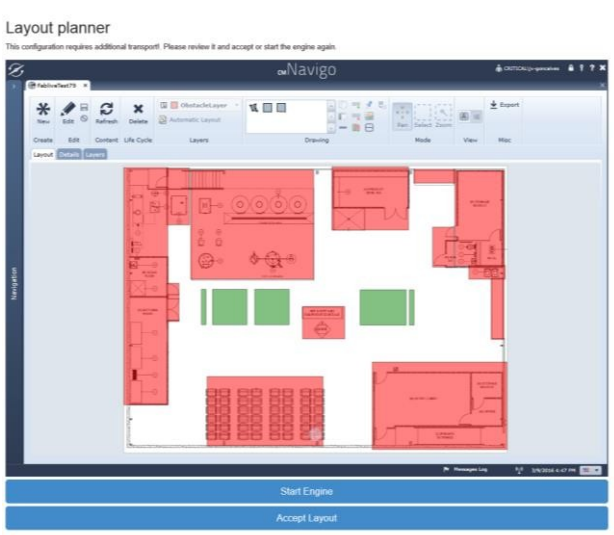


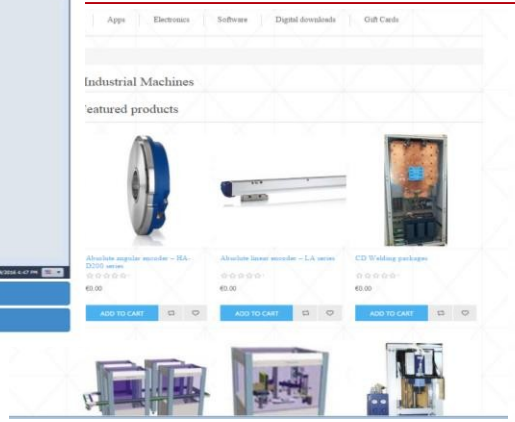


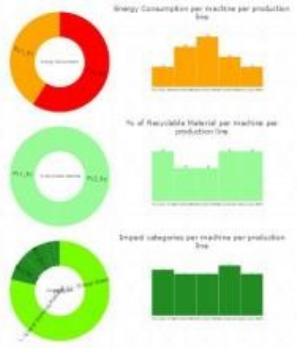
System level

Tools for planning and assessment









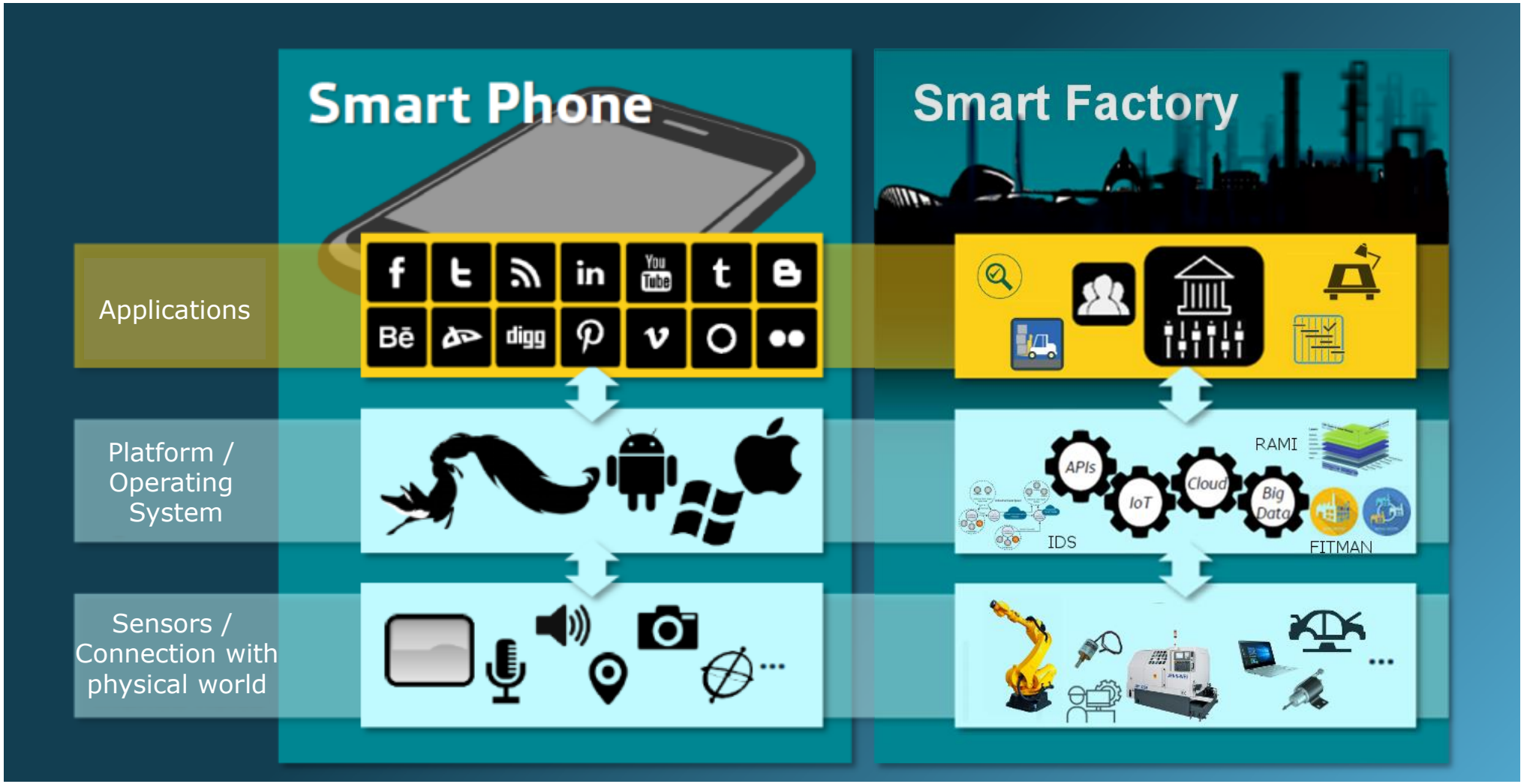
Functionalities:

- Generic planning and assessment software tool
- Extensible workbench architecture
- Requirements tool
- Solution generator
- System assessment tool
- Layout planner
- Market place for re-used equipment
- Integrated software suite for planning and decision support

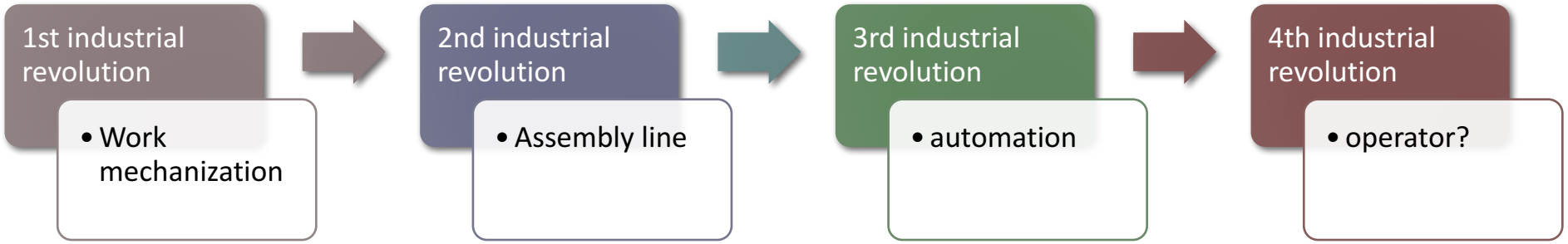
Personalised Production

INTELLIGENT MANUFACTURING ENVIRONMENTS

Intelligent Manufacturing Environment ecosystems



Intelligent manufacturing environments & human



U.PORTO
FEUP FACULDADE DE ENGENHARIA
UNIVERSIDADE DO PORTO

SYSTEC | RESEARCH CENTER FOR SYSTEMS & TECHNOLOGIES

ENABLING PERSONALISED PRODUCTION WITH INTELLIGENT MANUFACTURING ENVIRONMENTS

GIL GONÇALVES, UNIVERSITY OF PORTO, PORTUGAL

gil.goncalves@fe.up.pt

http://systec-fof.fe.up.pt/systec/web_pt.html

Q&A

- Security and dependability in the automatic update of applications and configuration parameters.

- Reconfigurability (and flexibility) in the logical layer (software and control); physical layer is not addressed.

- Quality assurance is executed at the machine level and quality information shared with other systems (e.g. Quality Management System for certification and compliance).

- Extent to which data analytics is being used in the diferent levels (smart components and smart components cloud).

- Level of complexity of the artificial systems and the capability to interact with the operators.

- capacity of the humans to understand the automatic methods used for reconfiguration (system and machine level).

- What will be the driver for the 5th industrial revolutiom?