Digital Transformation of the Industry: R&D Challenges, Opportunities and Solutions

Interreg
EUROPEAN UNION
2 Seas Mers Zeeën
INCASE
European Regional Development Fund

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Industrial example: Case New Holland (CNH)

MathWorks Mission Statement

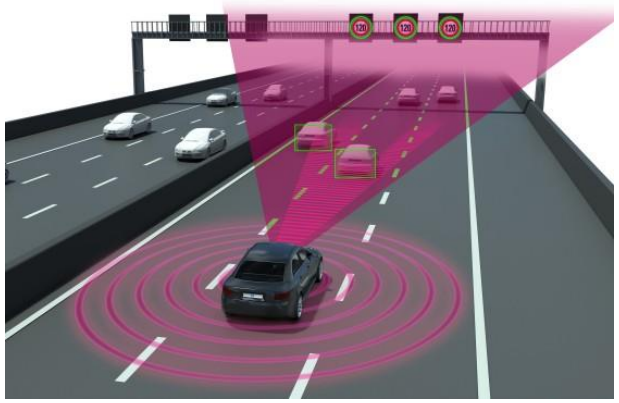
Change the world by accelerating the pace of engineering and science

- Founded in 1984, private owned
- Leading developer of mathematical computing software
- **4000** employees globally
- **Over >2500** software developers
- Benelux-office in Eindhoven
- >3 mio commercial users worldwide

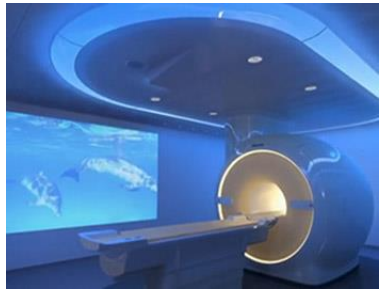
Key Industries

- Aerospace and Defense
- Automotive
- Industrial Automation and Machinery
- Transportation
- Communications, Electronics and Semiconductors
- Biotech and Pharmaceutical
- Energy Production
- Financial Services
- Education








MATLAB

Analyze data, develop algorithms, and create mathematical models

Explore MATLAB

SIMULINK

Run simulations, generate code, and test and verify embedded systems

Explore Simulink

R2018a » See what's new in the latest release of MATLAB and Simulink

Deep Learning

Data Analytics

Internet of Things

Motor and Power Control

Wireless

More Solutions

Agenda

- Innovation Challenges, Approaches and Enablers
- Model-Based Design and Virtual Commissioning
- Data Analytics and Machine Learning

Common Concerns when Innovating

Do we know the “thing” works when we turn it on?

Have we validated malfunctions and safety?

How big are the risks of returns?

Projects concerning complex and big

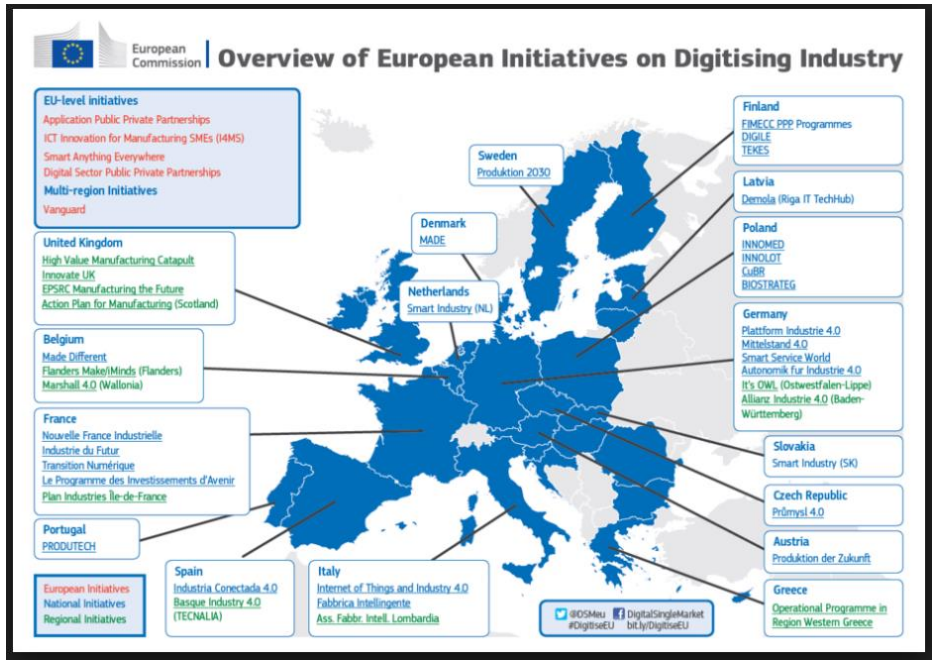
Outcome uncertain, issues found at the end

Risks from delays and quality issues

New Challenges and Trends:

Digital Transformation, Industry 4.0
Internet of Things
Data Analytics and Machine Learning

Digital Transformation of the Industry: is everywhere



- **Higher flexibility** given by small batches production with the economies of scale
- **Higher speed** from prototyping to mass production using innovative technologies
- **Increased productivity** thanks to lower set-up time and reduced downtimes
- **Improved quality** and scrap reduction thanks to real time production monitoring through sensors
- **Higher competitiveness** of products thanks to additional functionalities enabled by *Internet Of Things*

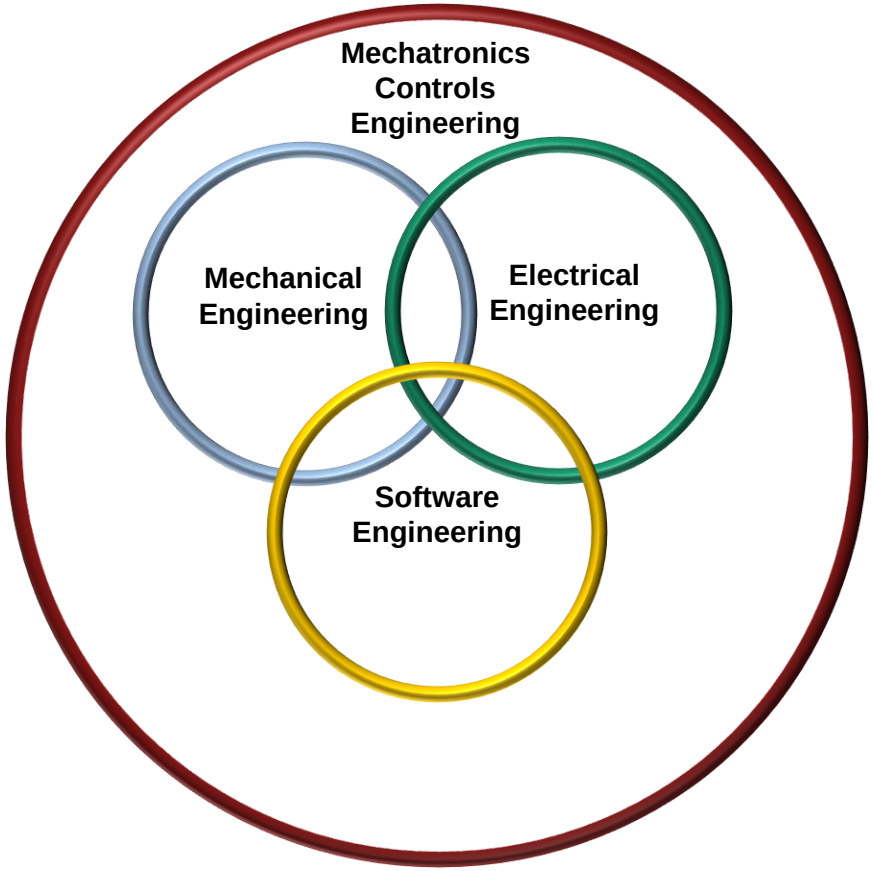
Digital Transformation: Learnings from studies and programs

- Customers want increasingly **individualized products**. *“sample-size 1”*
- **Autonomous machines** which do not require costly programming to meet new requirements. *“Smart products”*
- Intelligent **products that collect data** to **optimize** processes and develop new products
- **Competitive threats** from players like IBM, Amazon and Google.
- Opportunities for **innovative business models and services**. Particularly for SME’s. “Servitization”

Approaches and Enablers
to embrace Digital Transformation

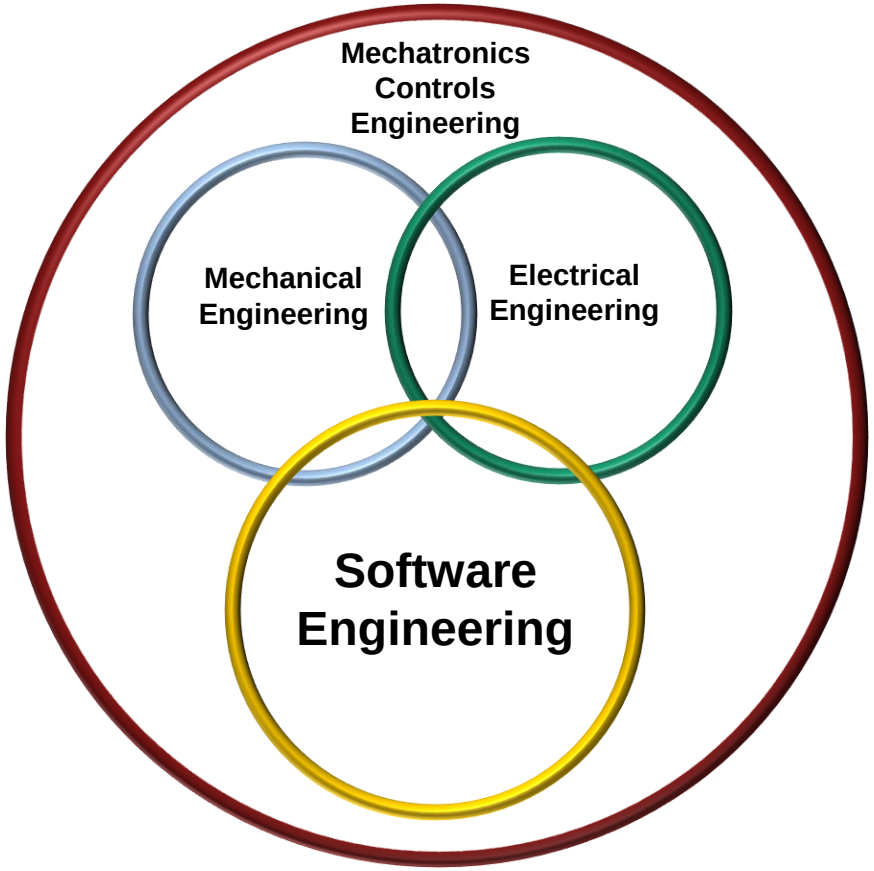
Key Enabler: Mechatronics

- **Mechanical Engineering, Electrical Engineering and Software Engineering** – and their interaction



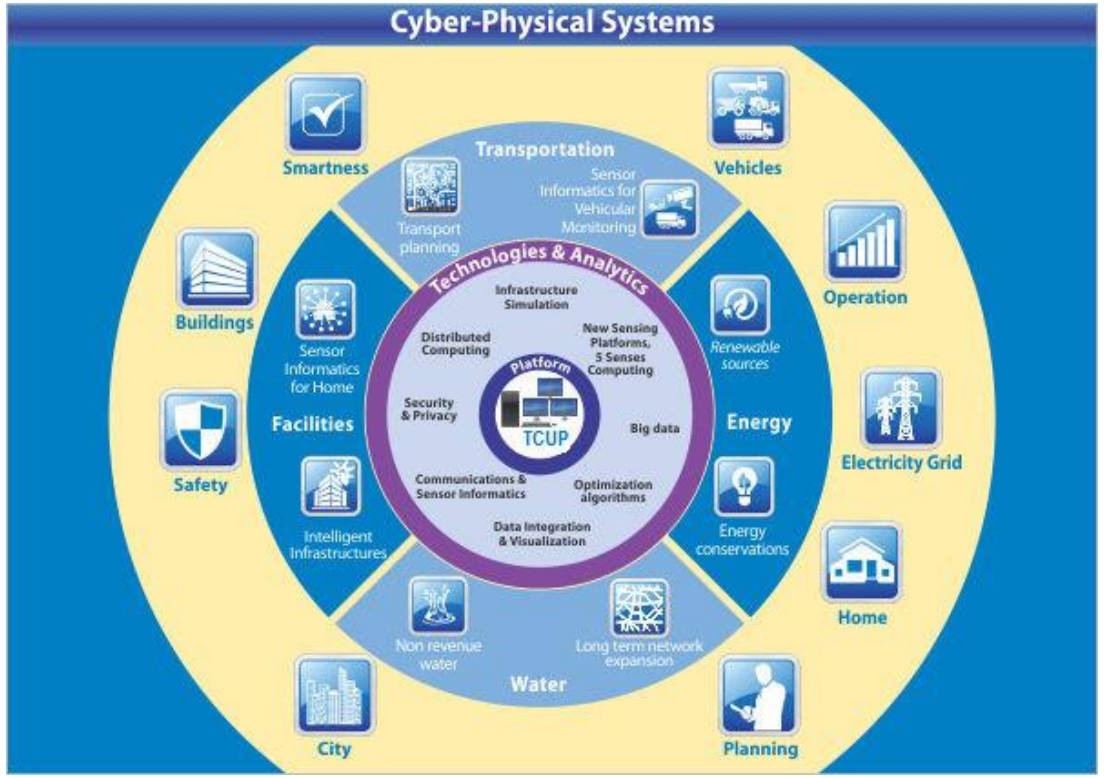
Key Enabler: Mechatronics

- **Software** has become the leading domain in mechatronic development



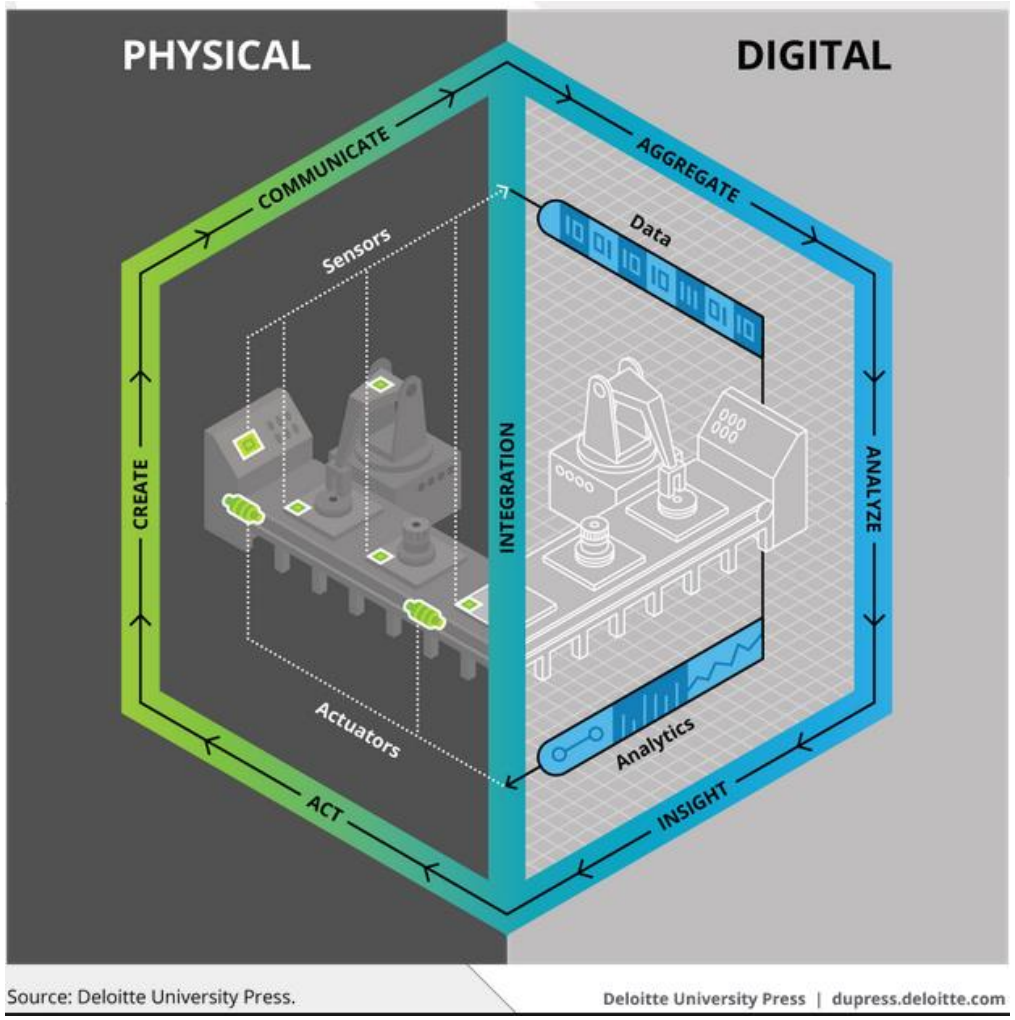
Key Enabler: Cyber Physical System

- A mechanism controlled by computer-based algorithms, tightly integrated with the Internet
- Process control based on embedded systems
- Examples: smart grid, autonomous automobile, medical monitoring, robotics



Key Enabler: Digital Twin

- A digital replica of physical assets, that can be used for various purposes.
- Integrate machine learning and analytics to create living digital simulation models that continuously learn and update themselves



Are you ready for Digital Transformation?

Access Data

- Sensors
- Files
- Databases

Analyze Data

- Data Exploration
- Preprocessing
- Domain-specific algorithms

Develop System

- AI Model
- Algorithm, Process
- Physical

Deploy

- **Desktop apps**
- **Enterprise systems**
- **Embedded devices**

Model-Based Design and Virtual Commissioning

Vintecc Develops PLC System for Multi-Axle Harvesting Machine Using Model-Based Design

Harvester incorporating the Vintecc control system.

Challenge

Develop a PLC-based control system for a four-axle, 100-ton capacity harvesting machine

Solution

Use Model-Based Design to develop controller and plant models, verify designs with MIL and HIL simulations, and generate production Structured Text for PLC deployment

Results

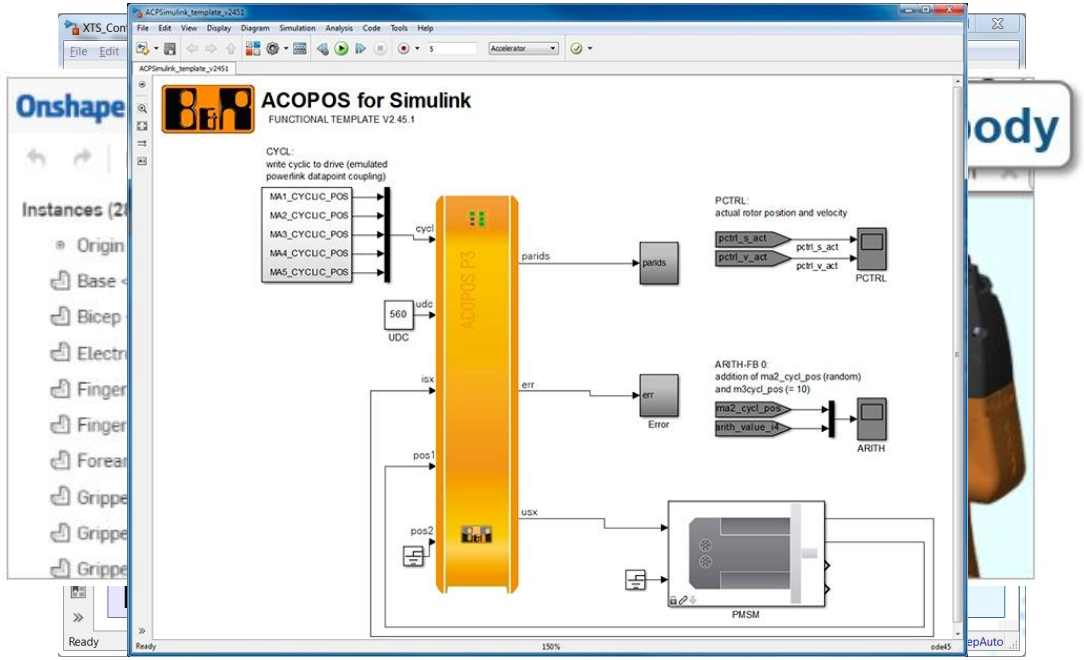
- 90% of design verified before hardware was available
- Development schedule shortened by months
- New features implemented within days

"Model-Based Design sped development enormously, made it possible to offer additional features with little additional work, and gave us a high level of confidence in the software we delivered. Without modeling and simulation, we might still be struggling to get the system up and running."

Vincent Theunynck
Vintecc

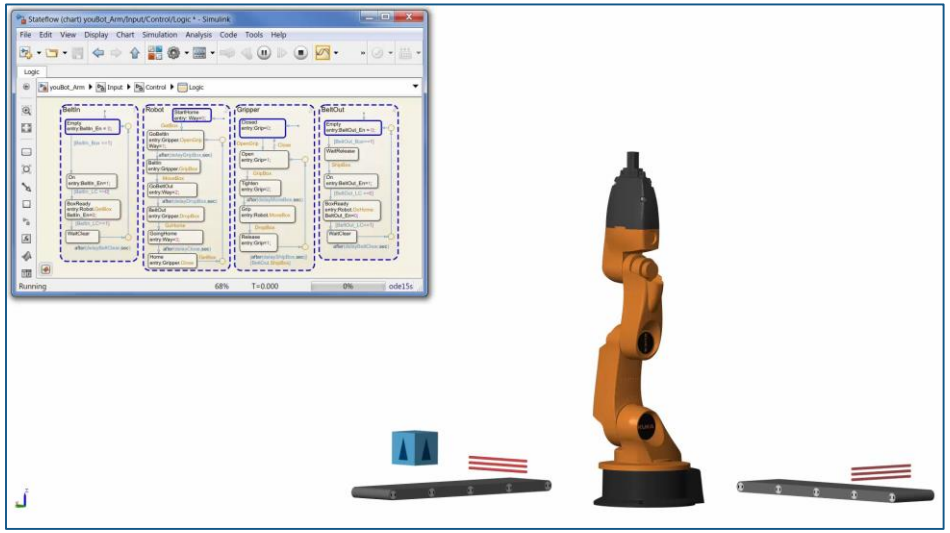
Link to user story

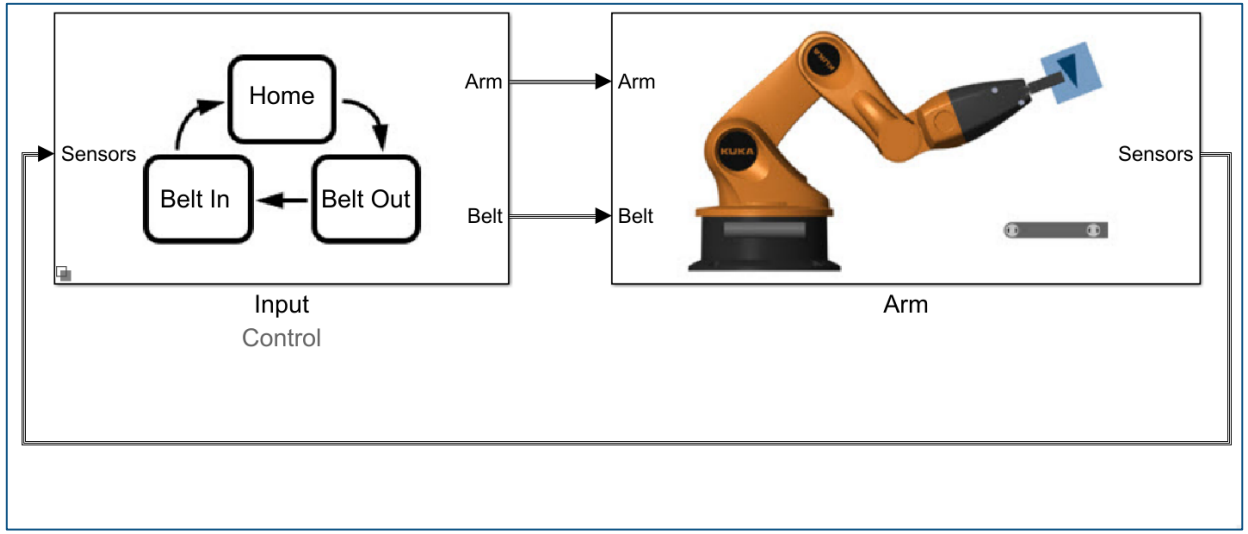
Step 1: System Modeling



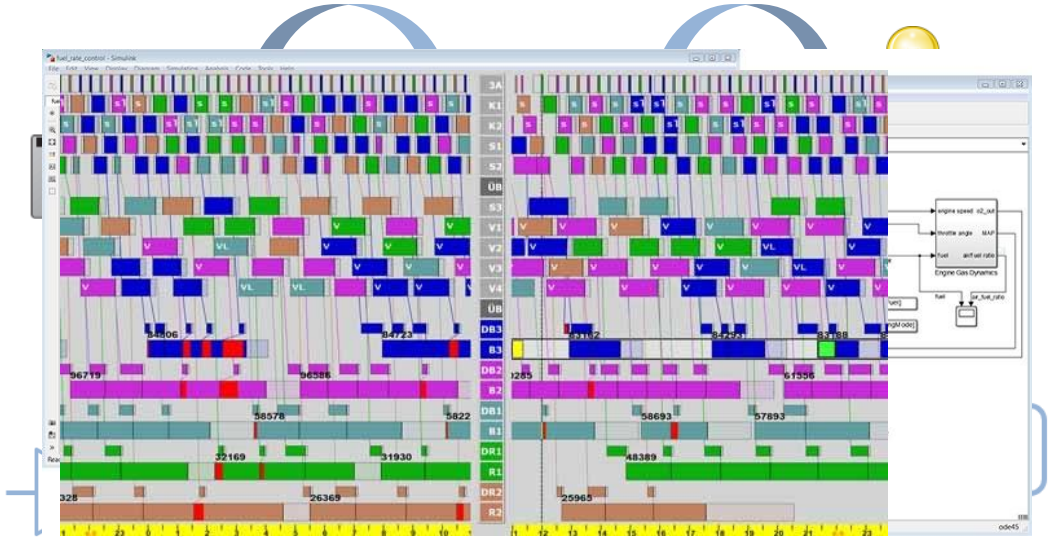
- Model your plant (mechanics, hydraulics, etc.) and controls (PID, state machine, etc.) in one single environment
- Use component models offered by MathWorks and 3rd party vendors
- Reuse CAD drawings through import for dynamic mechatronic simulations
- Identify your system behavior from measured data

Need for Multi-Domain Simulation



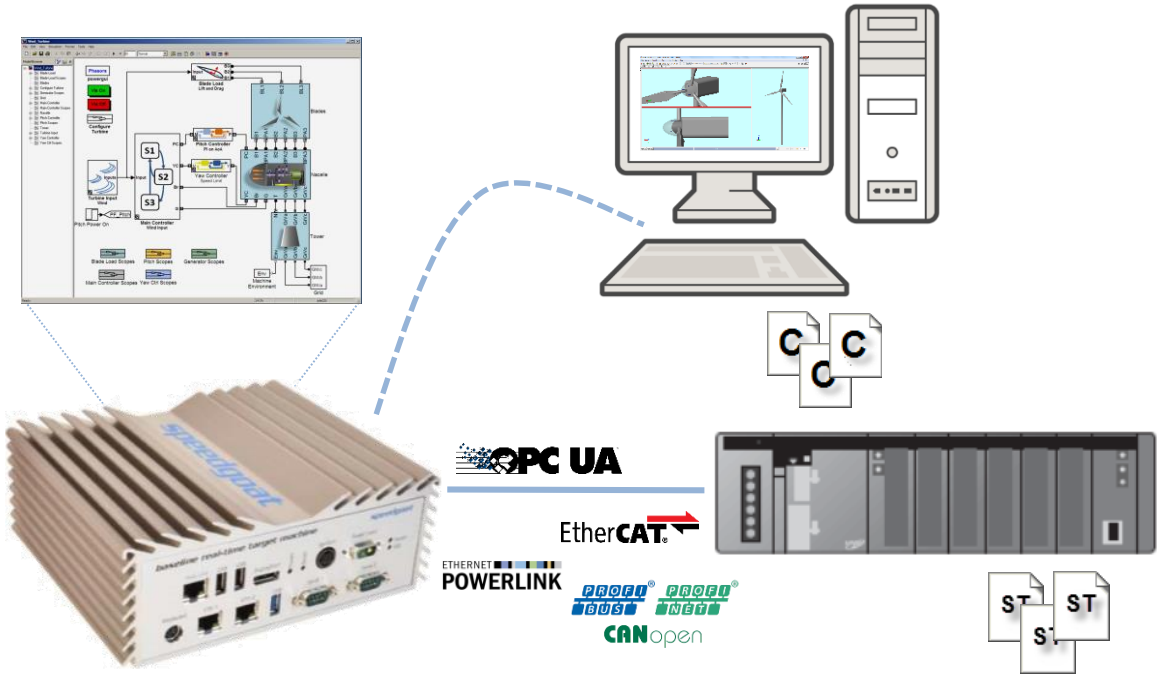


Step 2: Desktop Simulation



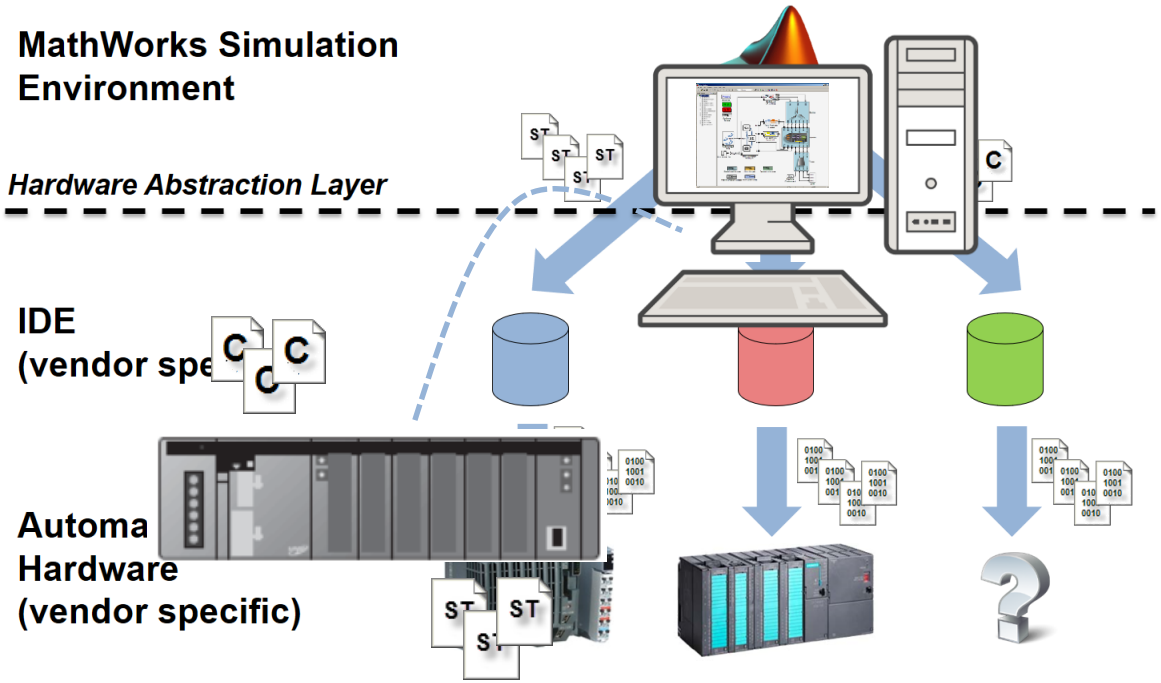
- Prototype new functionality and combine with existing code
- Perform automated system tests that would not be feasible outside of simulation and introduce faults
- Find optimal parameters and size components correctly
- Optimize product or process performance early in the project

Step 3: Hardware in the Loop



- Emulate the behavior of the physical system (plant model) in real-time
- Connect the virtual plant to your PLC or industrial PC (e.g. over an industrial fieldbus or OPC UA)

Step 4: Production Deployment



- Design and test functionality independently from hardware
- Debug real-time algorithms directly from Simulink

Vendor	IDE	IEC 61131-3	C/C++	Connections Partner
3S - Smart Software Solutions	CODESYS	✓		✓
B&R Industrial Automation	Automation Studio	✓	✓	✓
Bachmann Electronic	SolutionCenter	✓	✓	✓
Beckhoff Automation	TwinCAT	✓	✓	✓
Bosch Rexroth	IndraWorks	✓	✓	✓
Mitsubishi Electric	CW Workbench		✓	✓
Omron	Sysmac Studio	✓		✓
Phoenix Contact	PC WORX	✓	✓	✓
Rockwell Automation	RSLogix / Studio 5000	✓		✓
Siemens	TIA Portal / STEP 7	✓	✓	✓

Data Analytics and Machine Learning

Use In Operations

- Use models for health monitoring and predictive maintenance
- Reproduce errors from field data
- Train operators on new systems
- Use machine vision for non-invasive quality control

Mondi Implements Statistics-Based Health Monitoring and Predictive Maintenance for Manufacturing Processes with Machine Learning

One of Mondi Gronau's plastic production machines, which deliver about 18 million tons of plastic and thin film products annually.

Challenge

Reduce waste and machine downtime in plastics manufacturing plants

Solution

Use MATLAB to develop and deploy monitoring and **predictive maintenance software that uses machine learning algorithms to predict machine failures**

Results

- More than 50,000 euros saved per year
- Prototype completed in six months
- Production software run 24/7

"MathWorks Consulting's support is among the best I've seen; the consultants are fast and exceptionally knowledgeable. We've already seen a positive return on investment from cost savings, and now we have more budget and time to complete more machine learning projects that will provide similar benefits."

Dr. Michael Kohlert
Mondi

Link to video

Link to user story

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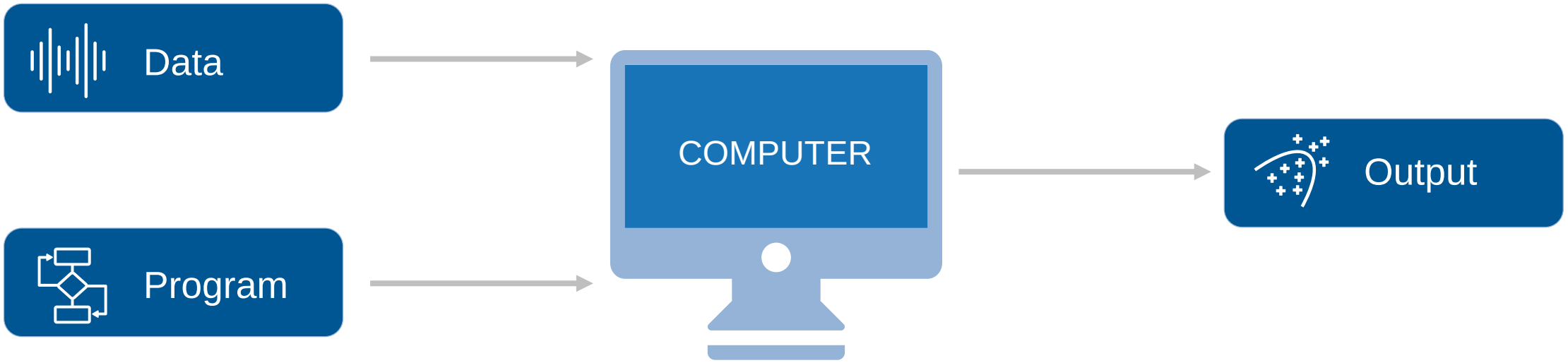
There are two ways to get a computer to do what you want



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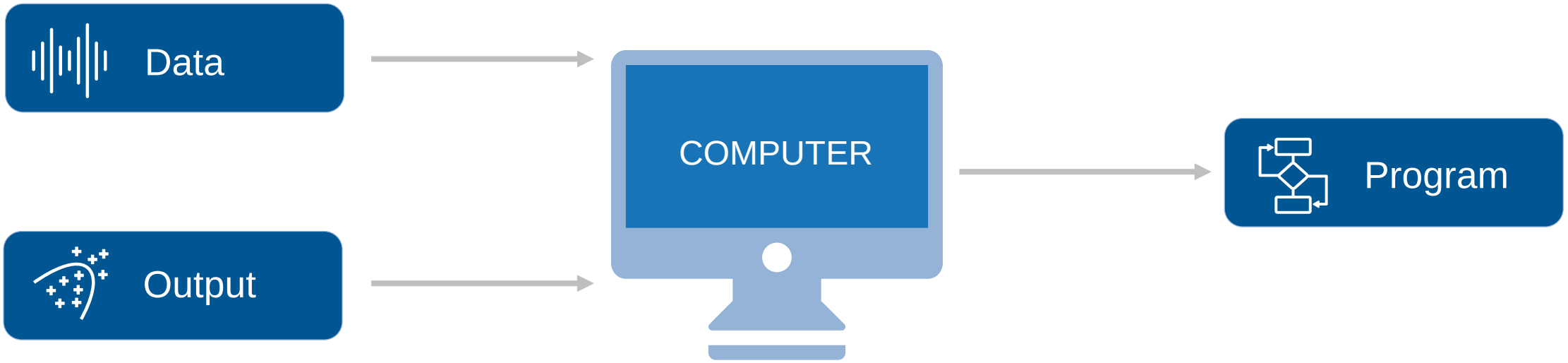

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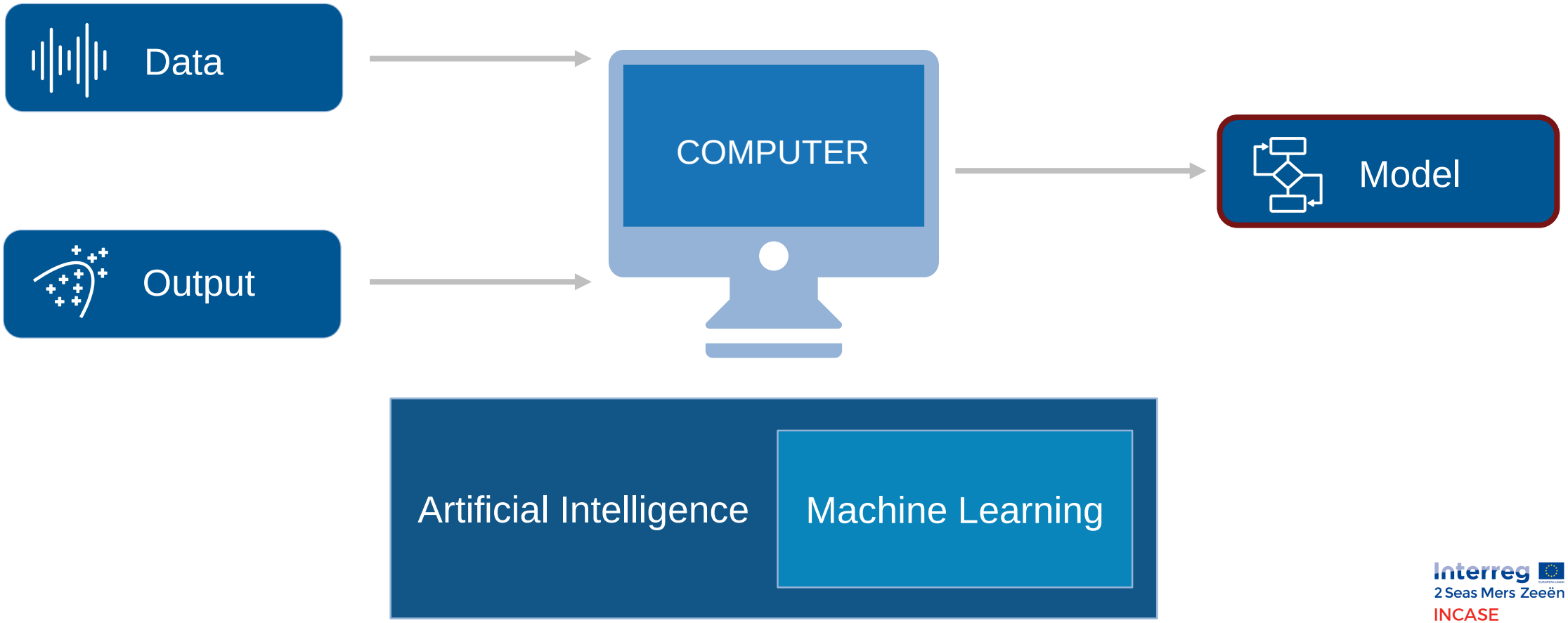
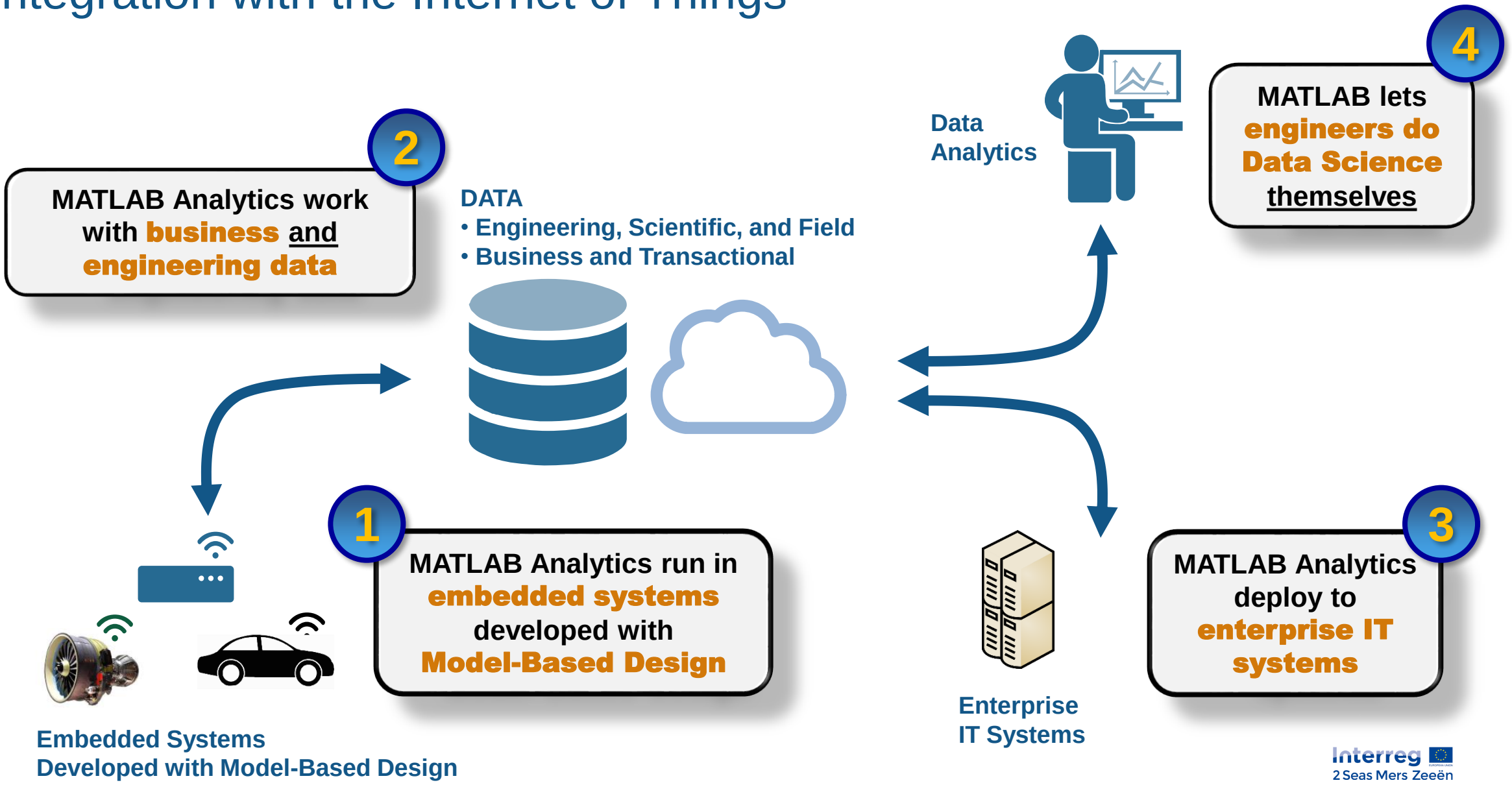


Integration with the Internet of Things



Why MathWorks: Solutions and Support

- Modelling and Simulation of whole systems
  - Offering component models for many fields complemented by data driven modelling
  - Reuse of CAD drawings for dynamic mechatronic simulations
  - Co-simulate with 3rd party platforms
- Enabling
  - Rapid Prototyping and Target Code Generation
  - Test and Report Automation
  - Data Analysis and Analytics
- Key Benefits
  - Faster design and verification
  - Reduced commissioning efforts
  - Virtual validation of requirements, performance and failure modes
  - Broad HW and SW connectivity
  - Improved overall product quality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