Smart Model Predictive Control (sMPC)

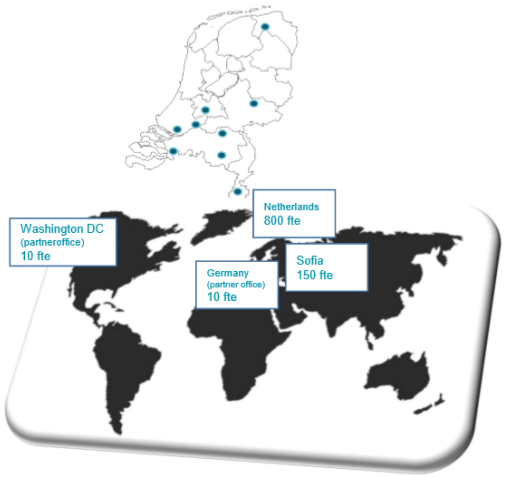
ICT

Stefan.Pluis@ict.nl

Agenda Smart MPC

1. ICT Group
2. MPC Trends
3. Basics and Approach
4. References
5. Resume, Q&A

ICT Group

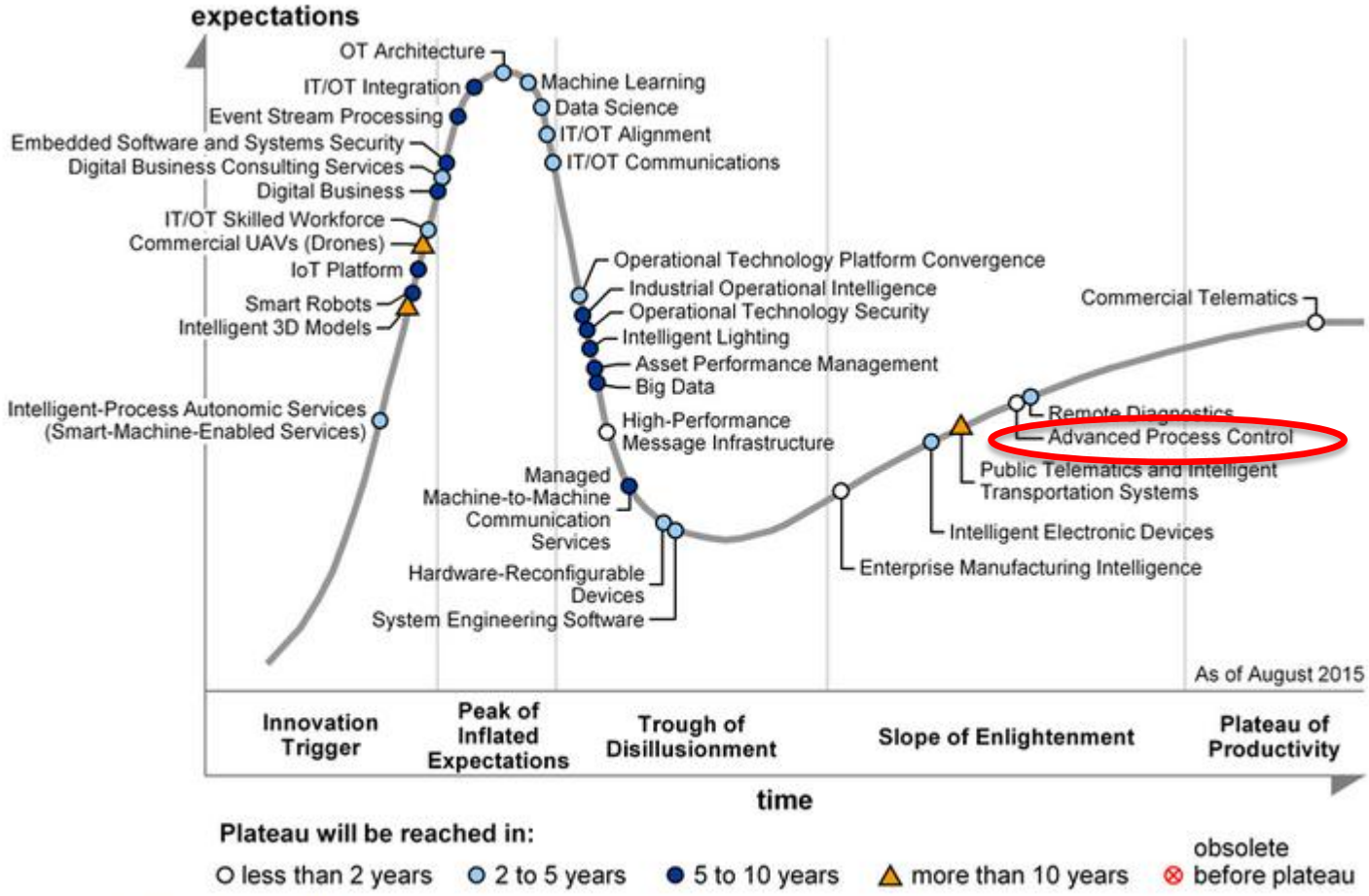


ICT Group is an international technology services and solutions company, delivering industrial services, consulting, systems integration and managed services.

ICT Group is focused on technology that powers progress in the digital transformation at our public and private customers. It is listed at Euronext Amsterdam.

- Annual revenues around € 100 million
- Over 900 technologists in 5 countries delivering worldwide services
- Headquarters in The Netherlands
- ICT GROUP operates under the following brands:

Maturity of MPC (APC)



Source: Gartner (August 2015)

Status MPC

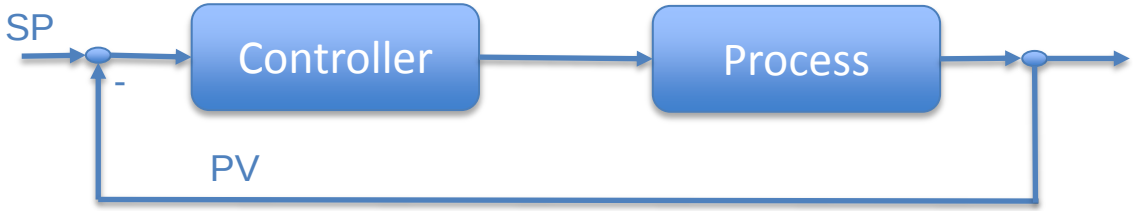
- Result MPC (APC):
  - Optimize production yield
  - Reduce energy usage
  - Improve product quality
  - Increase process stability
- Large process industries (Oil and Gas) use it already for decades
- Now extra push through Cloud, remote collaboration, cheaper computing power -> other markets can benefit
- ROI: depends on case but most of time < 1 year
- Maturity: early mainstream

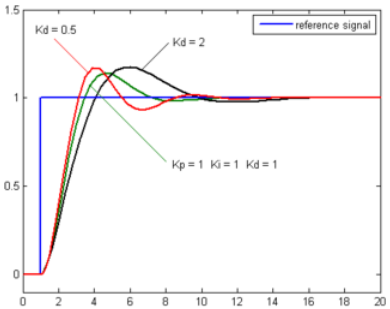
Source: Gartner 2015

PID / MPC

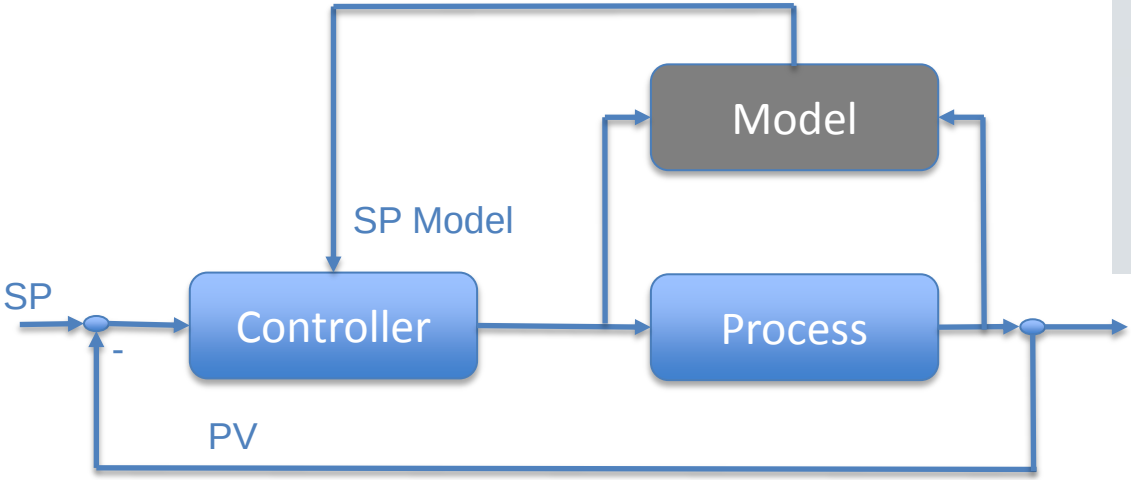
Age of PID controller: > 100 year

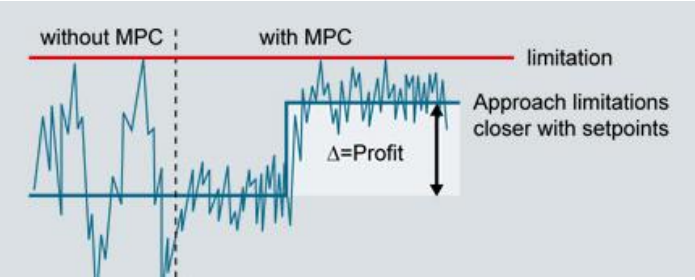
Classic PID



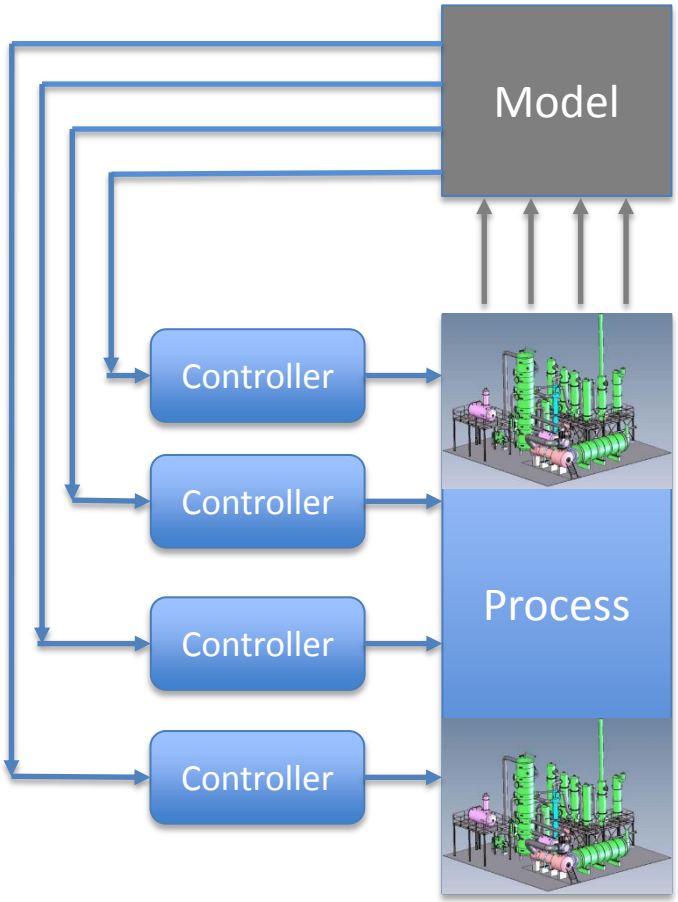


Model Based Control





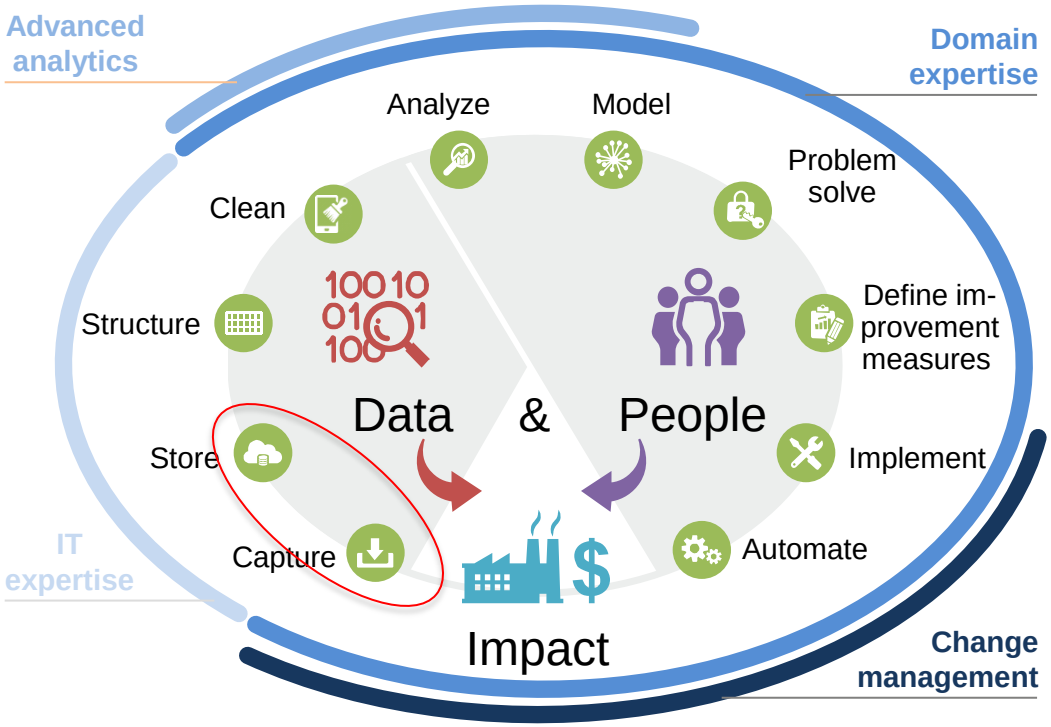
Multiple Controllers, influence on each other



Problem: how to get an accurate model of the process?

Approach to build a model (sMPC)

Solution: Building a model of the process based on your field data of the process (historian)



Capture data from a variety of sources such as sensors, lab results, human observations

Store and archive large data volumes using state-of-the-art data management solutions

Structure the data and define relationships

Clean the structured data by identifying and resolving gaps

Analyze using proprietary tools

Model through advanced analytics techniques, e.g., neural networks

Problem solve combining analytics with industry and process expertise

Define improvement measures based on insights

Implement by working with people to change mindsets and behavior in order to achieve impact

Automate to increase efficiency

Unique step-by-step approach MPC

1. Business Case study

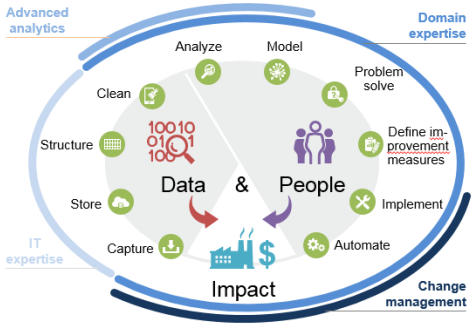
- data acquisition and preparation
- first modeling and sensitivity analysis
- Quick calculation of economical potential

2. Advanced analytics phase

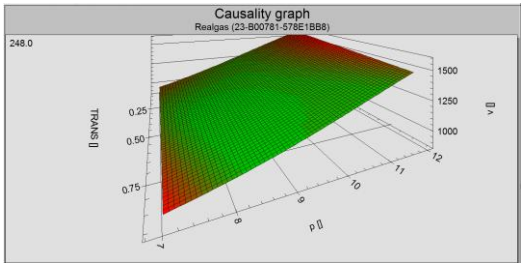
- comparison of sensitivity analysis and process knowledge
- determination of input variables and target values
- modeling and validation of the process model
- determination of optimized process points
- calculation of economical potential

3. Implementation

- integration of necessary hardware
- setup of database and software system
- online implementation of advanced and model based process control
- Verify Business Case



End Result: sMPC



Reason (input)

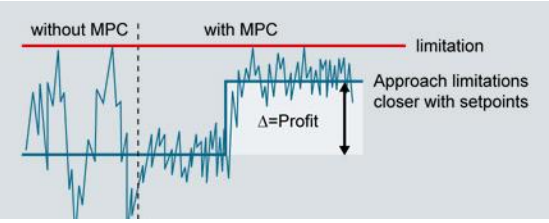
- temperature
- pressure
- discharge
- concentration
- engine power
- peroxide
- etc. ...

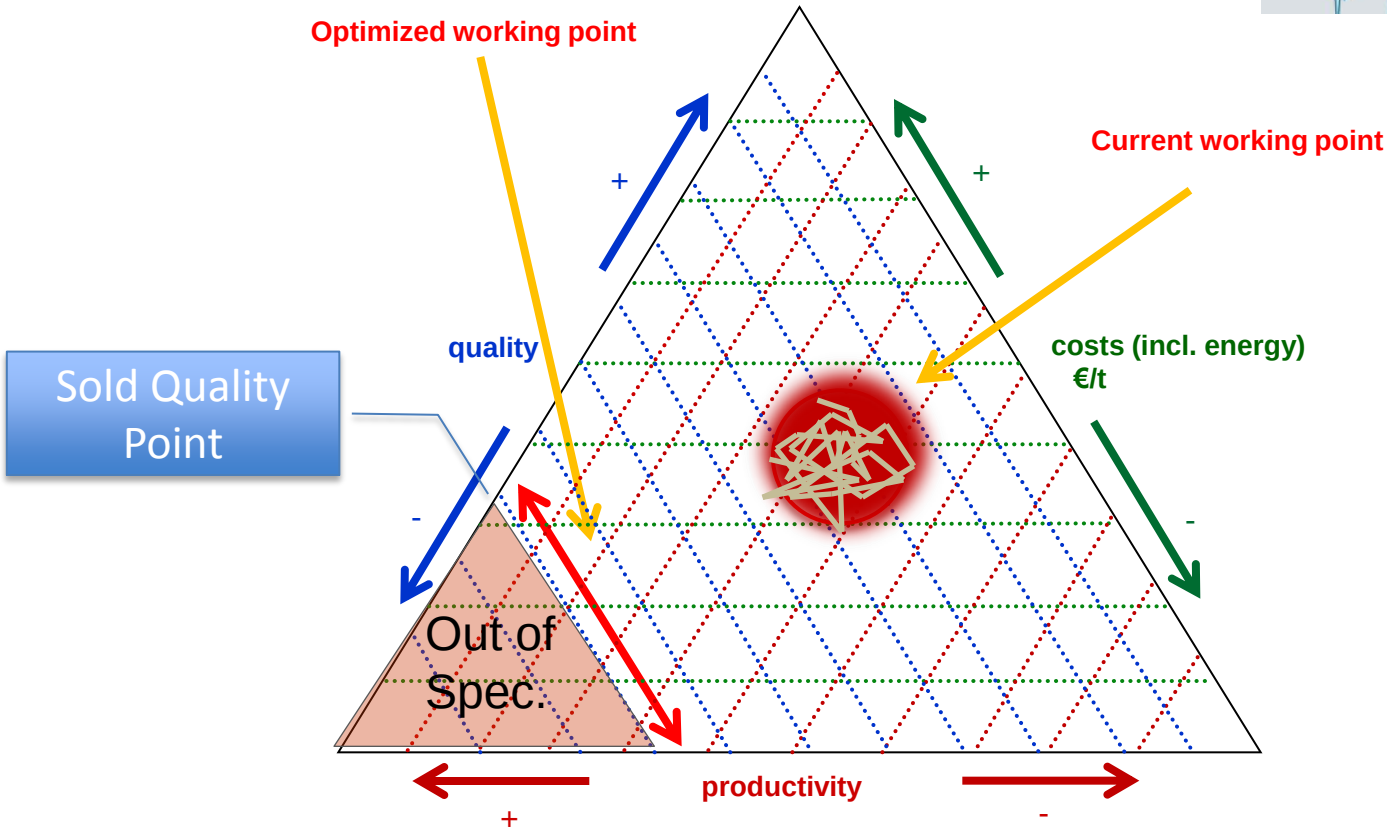
effect

- crop
- shrinkage
- MFI (Melt Flow Index)
- by-product amount
- degree of cross-linking
- color value
- energy consumption

Solution: model of the process based on your field data of the process (historian)

Goal: Optimization to target state





Normal extruder (example)

An analyzer on an extruder
(Göttfert SSR Rheometer)

Material

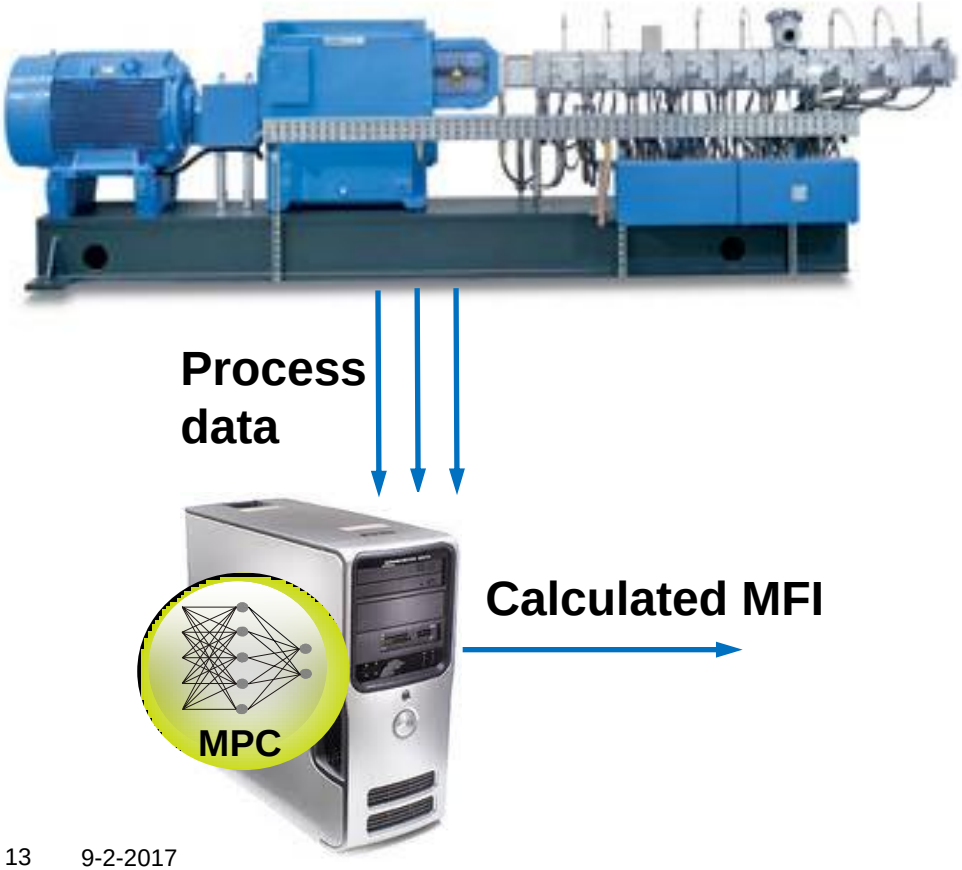
MFI measurement

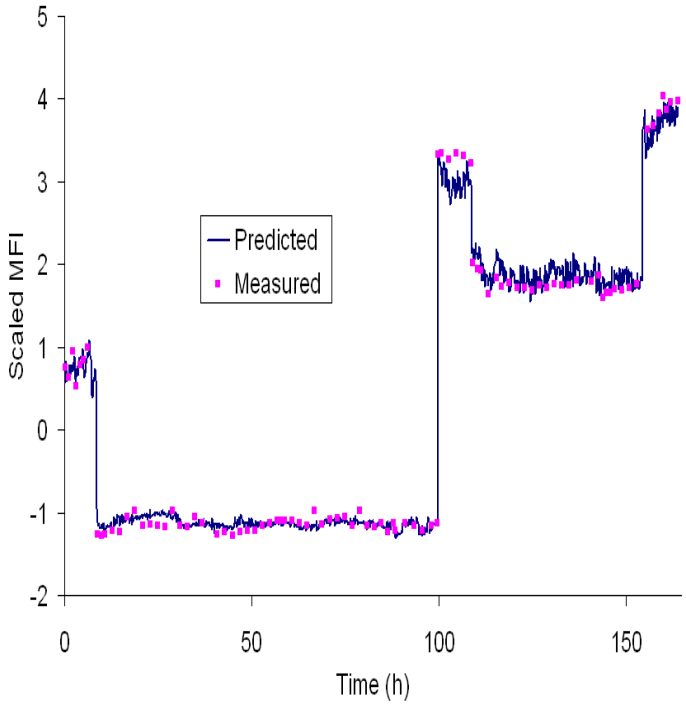
Disadvantages:

- availability
- high costs of service
- considerable effort of calibration for every product
- measurement (samples) is NOT acceptable for a continued MPC-System

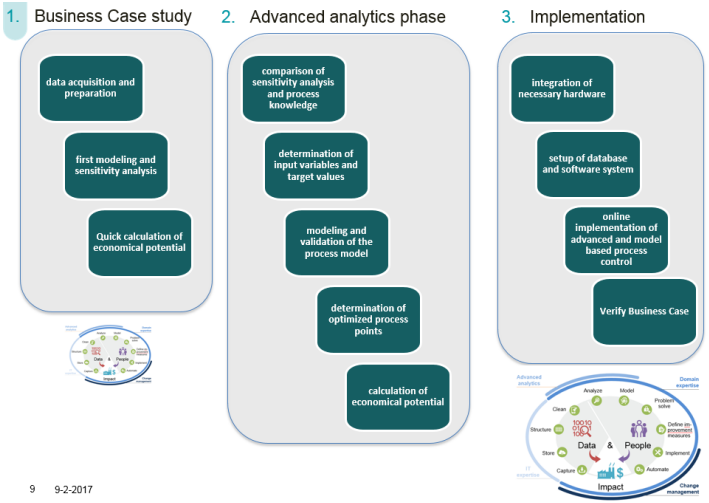
Extruder with a MPC (model)

MPC software replaces the Göttfert SSR Rheometer



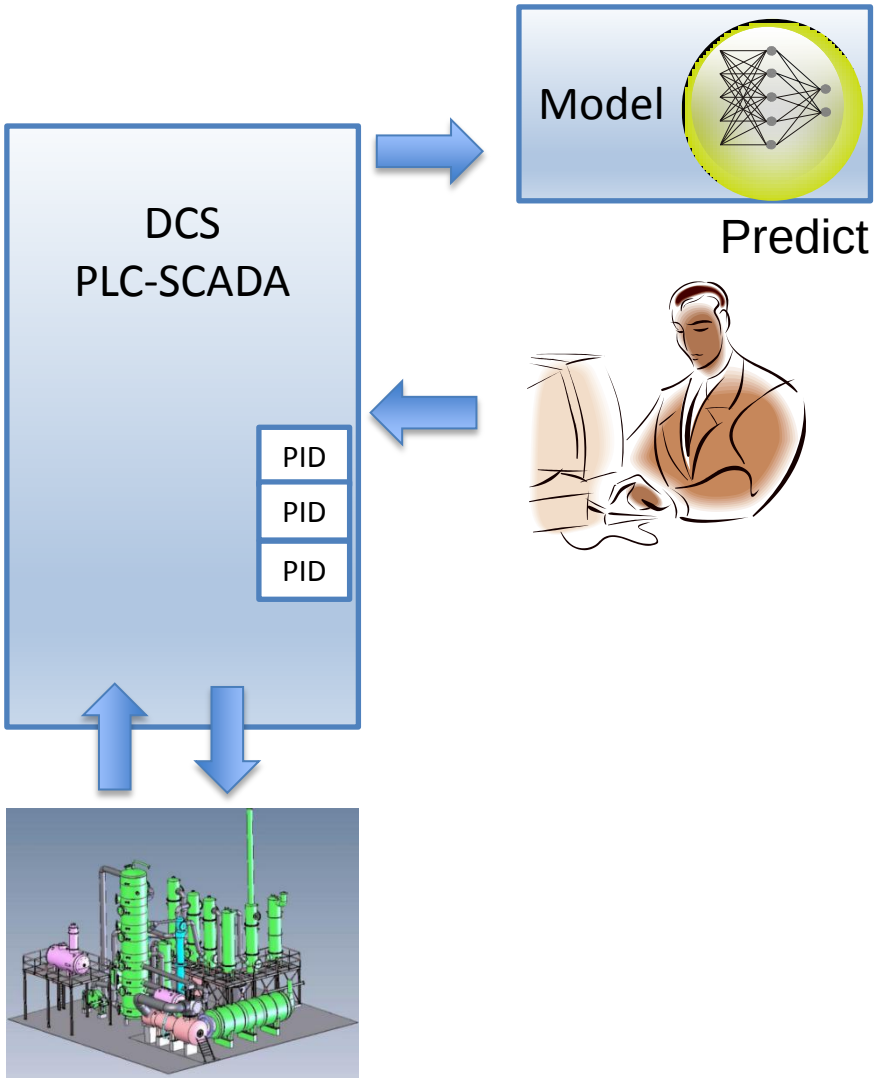


Process optimization: phased implementation



1. Business Case study
2. Advanced analytics phase
3. Implementation:
   A. Model: Virtual analyzer (advice: operator decision)
   B. Model: What-if analyses (advice + operator can do What If)
   C. Model Optimizer: Set point to process (closed loop)
   D. Model Optimizer + auto model training (closed loop + model tuning)

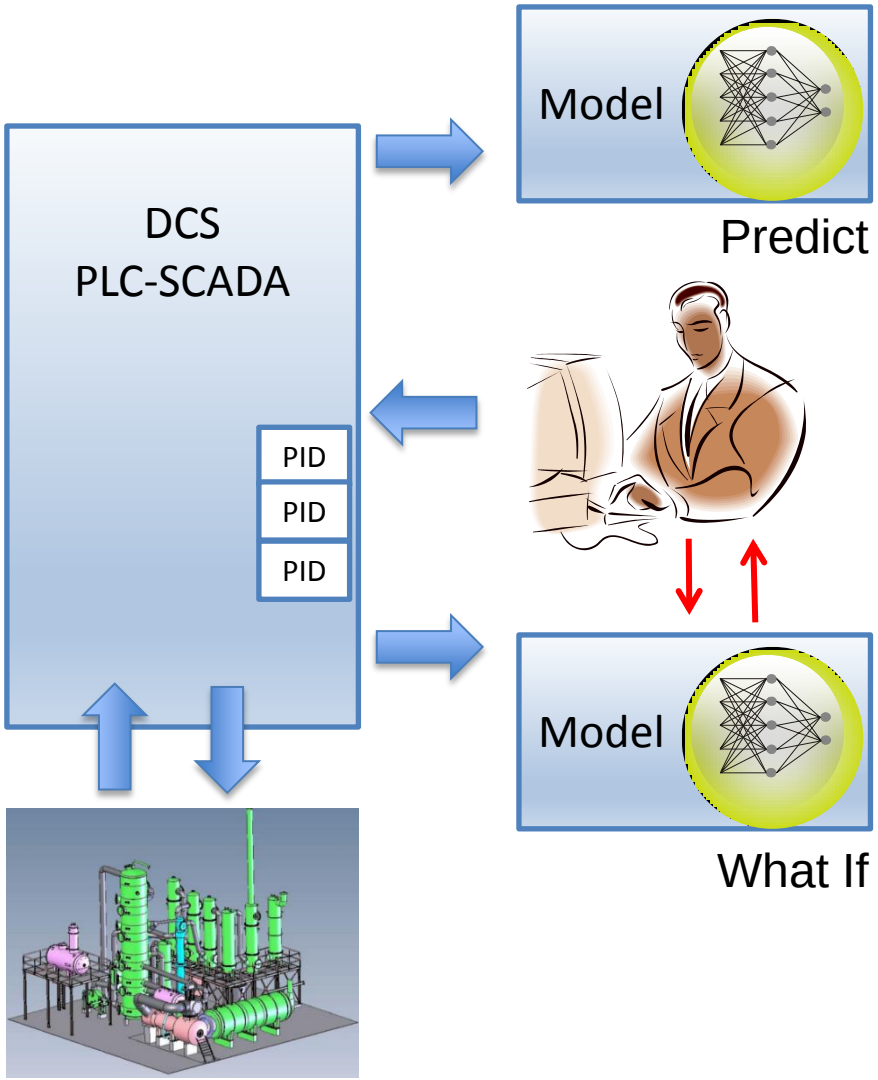
Process optimization phase A: virtual analyzer



MPC calculates from sensor inputs the outcome of a process

The operator will see the prognosis of the analysis online in the DCS and can manually adjust.

Process optimization phase B: what-if model

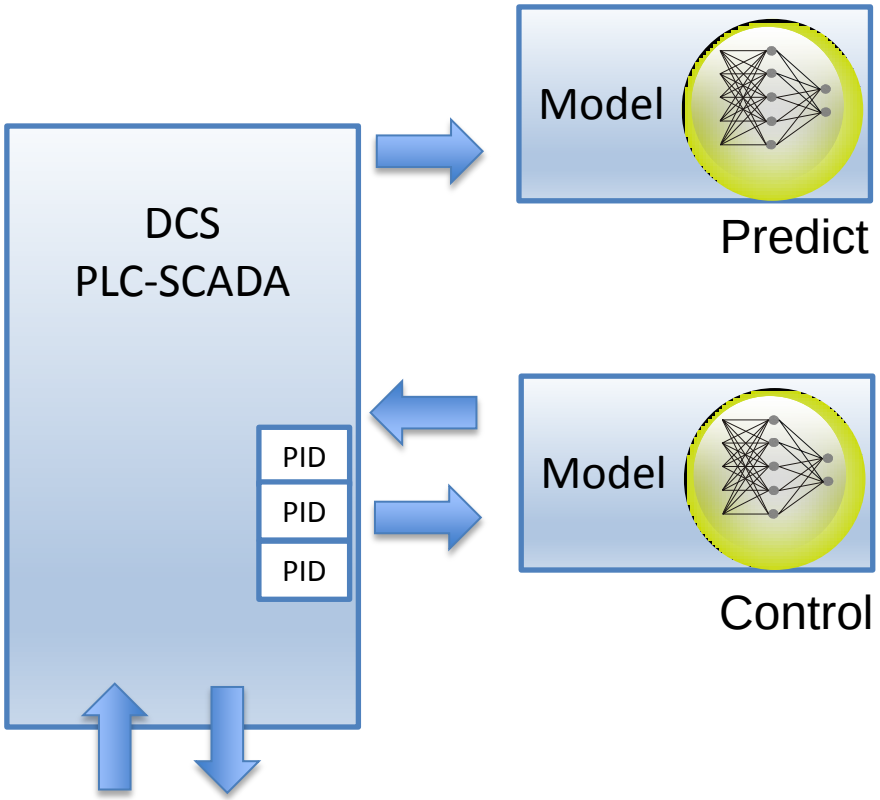


MPC calculates from sensor inputs the outcome of a process

The operator will see the prognosis of the analysis online in the DCS and can manually adjust.

The operator can make experiments with the model (setpoints) to learn to handle the process optimal

Process optimization phase C: optimizer



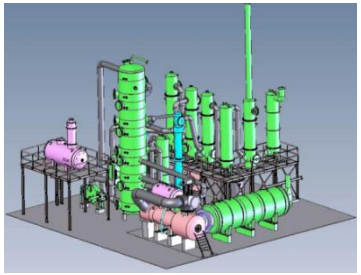
Predict / What if

Control

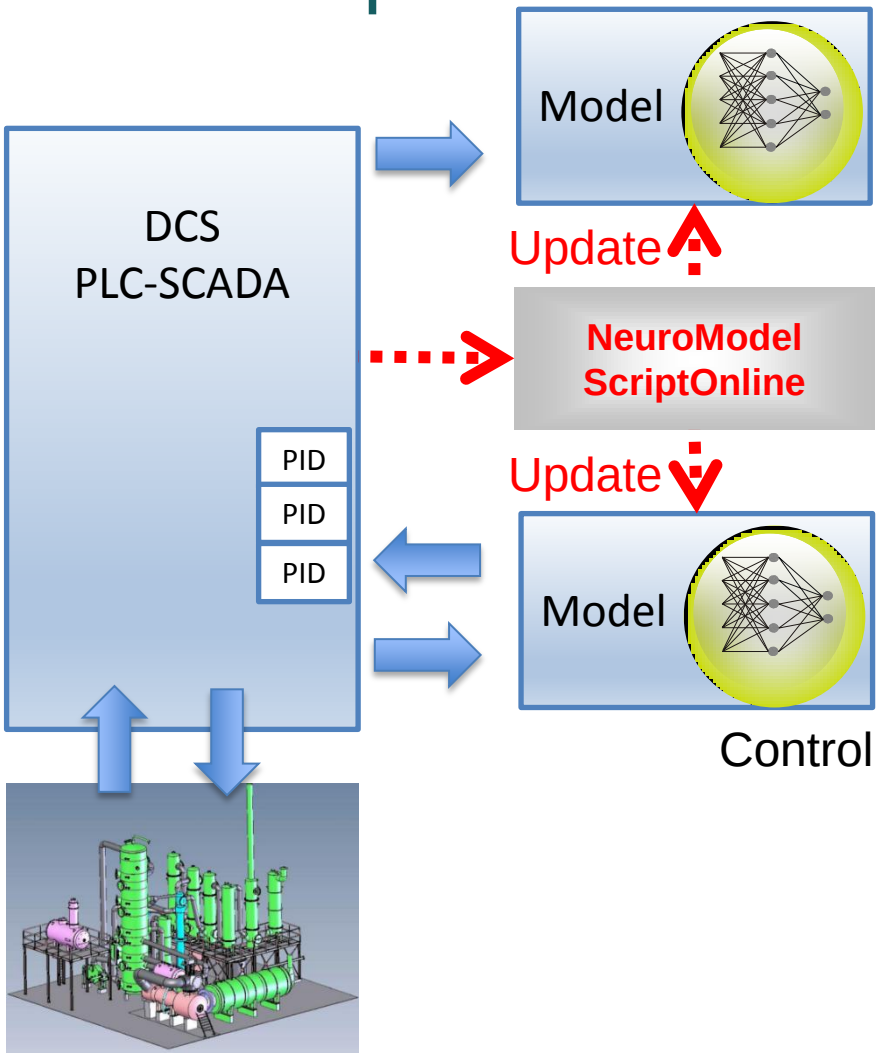
MPC calculates from sensor inputs the outcome of a process

MPC predicts the outcome of a process

MPC optimizes the process by automatically calculating the optimal setpoints + sends to process



Process optimization phase D: optimizer with model adaption



MPC calculates from sensor inputs the outcome of a processs

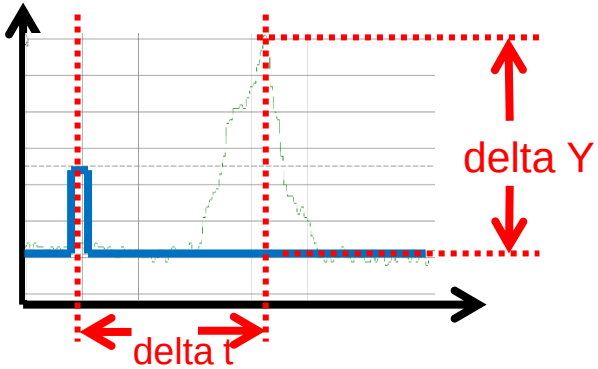
The models will be updated regularly

MPC predicts the outcome of a process

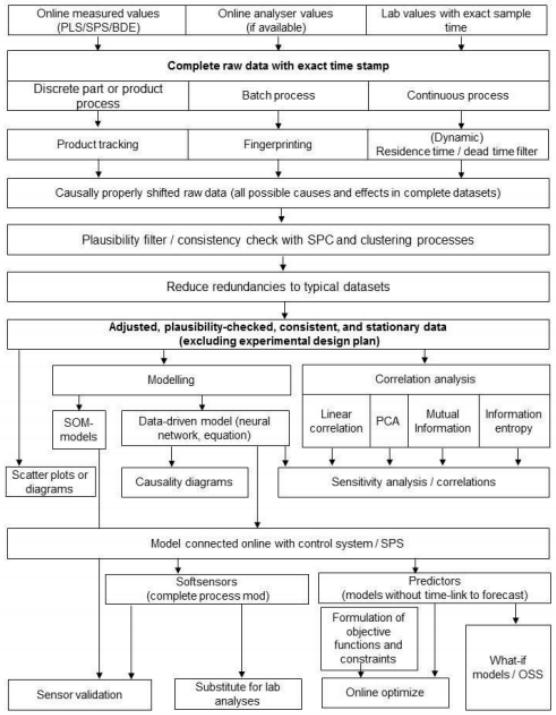
MPC optimizes the process by automatically calculating the optimal setpoints + sends to process

What is unique?

- Model based on Historical Data: no step-response.
- Model can be adjusted during production (Auto learning option).
- OPC and Database connection: independent of PLC-SCADA-DCS layer.



- Software according standard workflow for Big Data: VDI/VDE/GMA FA7.24 .
  - German standard developed by a.o. atlan-tec, McKinsey, SKZ, TUV, BASF, Siemens, Clariant, several Universities.



Reference sMPC

Problem**:**

- Quality Check (MFI) with Laboratory analysis was to slow
- The accuracy of Online-MFI-Sensor is to low (7% of range)
- The OA (operational availability) of the Online sensor was too low (61%)

Solution: MPC implemented

- The MPC has a OA of 98% and a accuracy of 2%
- The operator will get information about manipulable variables and the exact influence of control actions
- The changeover time between two qualities was reduced to 15%!

- Effect: Reduce loss of (out of spec) product to 30%
    - Costs: Project € 90.000,- ; Maintenance € 12.000,- per year
    - Savings: approx € 400.000,- per year

Reference sMPC

Problem:

- A Batch process must be checked by laboratory analysis
    - High waiting time in the night and on the weekend
    - One laboratory analysis was expensive
    - Big storage tanks are needed

Solution: MPC

- After implementation the analysis value was available 15 Minutes before the Batch was finished
    - Only 1 time each month the lab test is needed
    - Cost reduction (storage & laboratory): € 450.000,- per year

Reference sMPC

- Problem:
  - Splitting Air into N2, O2 and Argon is very energy consuming.
  - Production costs depend on energy cost, market prices of gasses and weather conditions (temperature, moist etc): complex calculation.
  - Argon is important because of high market price.

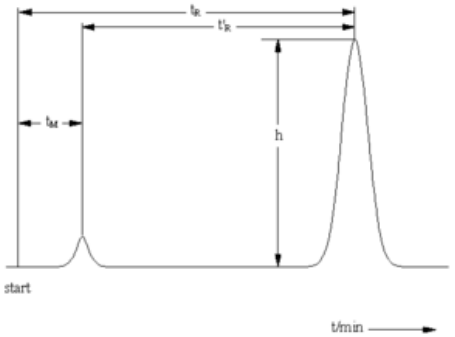
- Solution MPC:
  - Optimize the process regarding Energy consumption and available gases: maximize output (EURO) per kWh.

References sMPC (Other)

- Food: prediction of taste of potato chips without the use of test persons
- Chemical: super absorber for diapers: no waiting time for lab test
- Chemical: production of sunscreen lotion: no lab tests
- Cement: optimal binder in product: lower production costs
- Water: cleaning of wastewater with less energy use
- Pharma: better prediction of tablet properties
- Cosmetic: prediction of viscosity of shower gel: normal 4 days waiting and a lot of rework.
- And many more

Typical use of sMPC

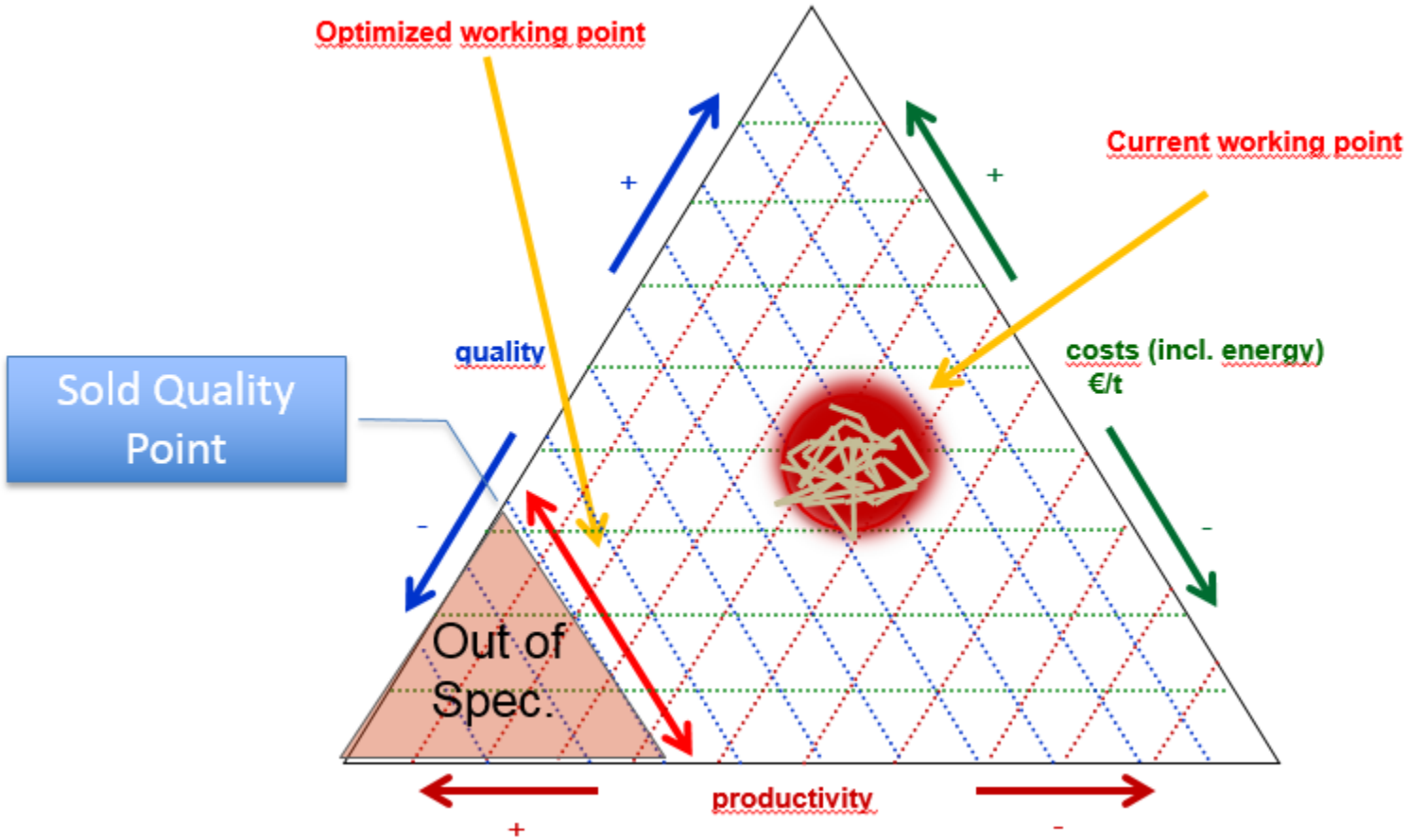
- Process with a big dead-time



- Process with laboratory delay time

- Process where several parameters influence each other

Resume



Building a model based on your process data (historian)

Questions?

Stefan.Pluis@ict.nl
06 - 270 87 340

We are available at our stand for questions.

ICT

Intelligence Connected Together

WWW.ICT.EU