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## AI supported Asset Health Monitoring with permanent sensors, AMAS

Dordrecht Process Safety conference  
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Dr. H.V.Schwarz

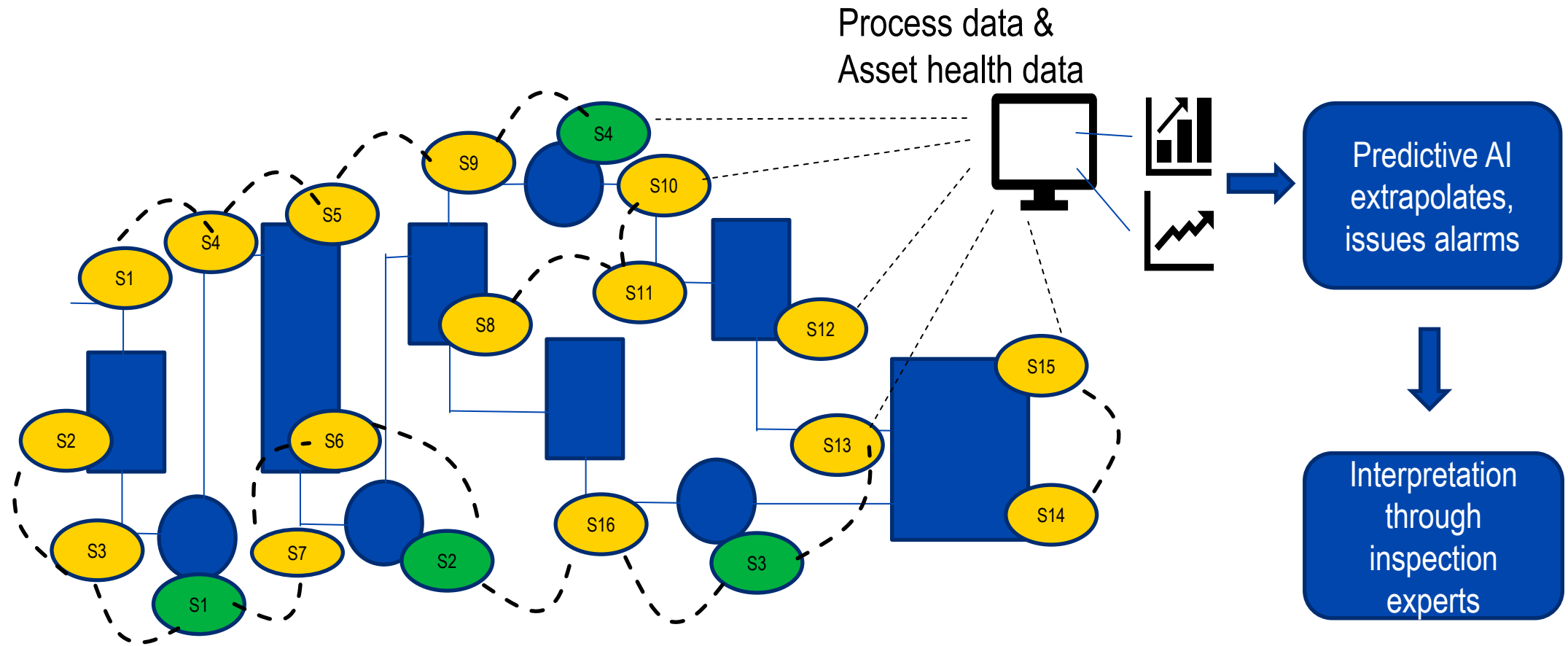


# Asset health monitoring for Industry 4.0

- AMAIS – **A**sset health **M**onitoring **A**I **S**upported
- The Vision behind AMAIS is a 'plug & play' system for 'asset health monitoring', the monitoring of plant integrity
- **Permanently installed sensors**, e.g. for **wall thickness**, transfer their data, preferably wireless, to a central data system, where they are evaluated by AI. The course of corrosion and other degradations are shown on a dashboard which issues **early warnings**
- The AI can also **detect correlations between process parameters** (e.g. *Temperature, Pressure, Flow,..*) and **corrosion rates**. This additionally requires the processing of data from the DCS.
- Konsortium:
  - TÜV SÜD
  - atlan-tec systems
  - sensor manufacturers,..



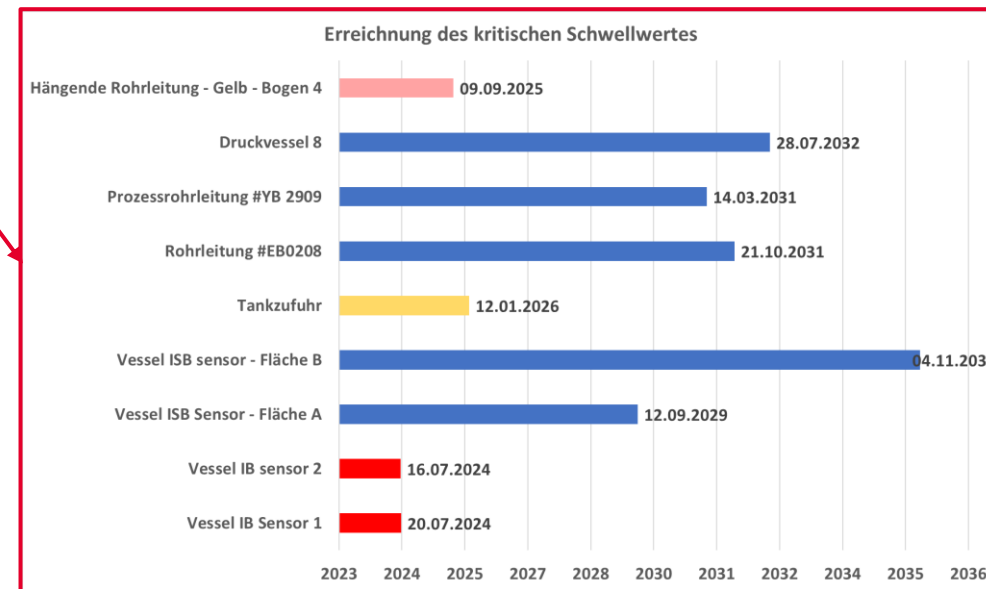
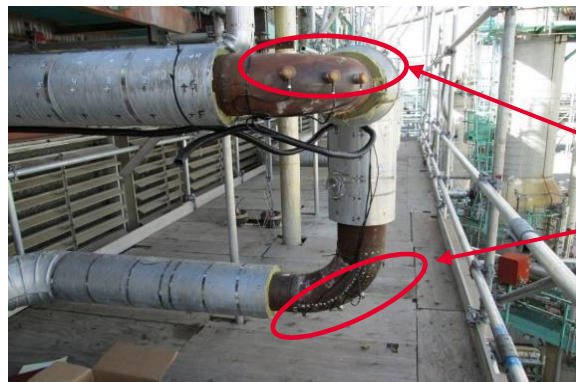
# Asset Health Monitoring supported by AI



# AM AIS Asset health Monitoring supported by AI

## Benefits of permanent monitoring:

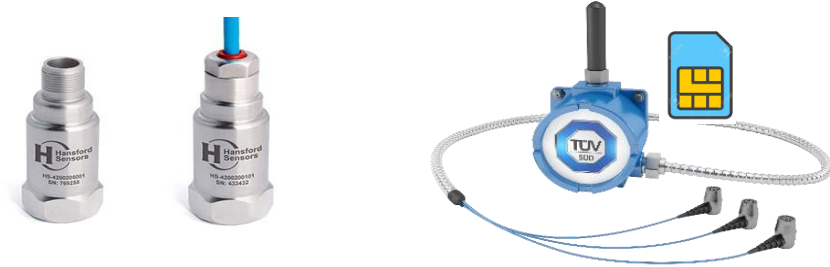
- 24/7 Information and transparency of integrity of critical equipments and units
- Reduced downtime of critical units, higher reliability
- Optimisation of Inspection intervals
- Predictive planning of repairs and maintenance
- Reduction of operating costs
- Solid data base for ‚remaining life‘ calculations
- Strong and traceable technical argument in applications for the extension of inspection intervals at authorities





# AM AIS Sensors

- **Ultrasound wall thickness sensors** for corrosion, erosion
- **Acoustic emission sensors** for the detection of stress and **cracks** in stationary equipment
- Acoustic emission sensors for the detection of degradation in **bearings of rotating equipment**
- **Humidity sensors** , e.g. under insulation
- **Vibration sensors** on critical piping and rotating equipment
- Sensors for the monitoring of **fouling** and deposits
- **Area sensors** for toxic and flammable gases (Leak Detection)
- **Soft-sensors** based on process data, e.g. for **fouling in heat exchangers**
- **Sensors printed on foils** (e.g. under insulation) for wall thickness, humidity, etc under development at partner company



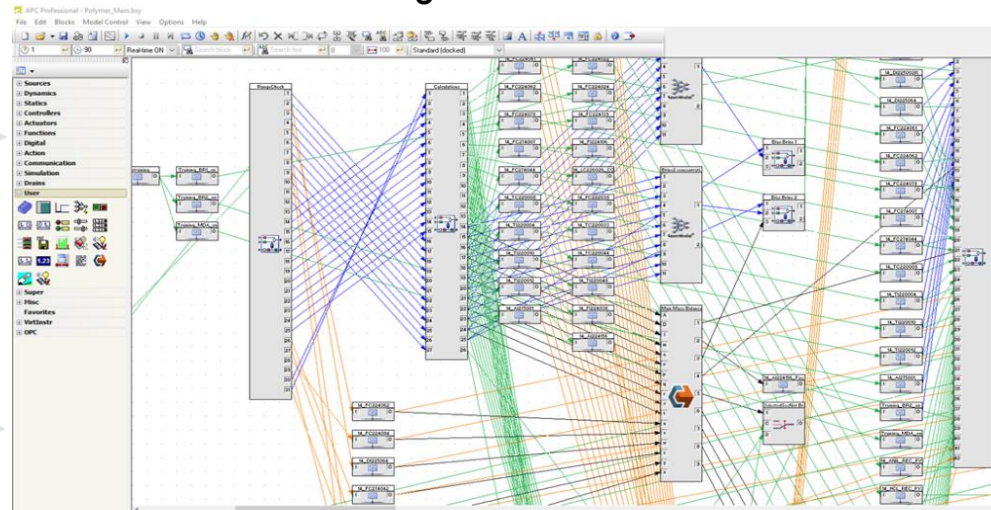
# AM AIS Asset health Monitoring AI Supported: concept



Various sensors

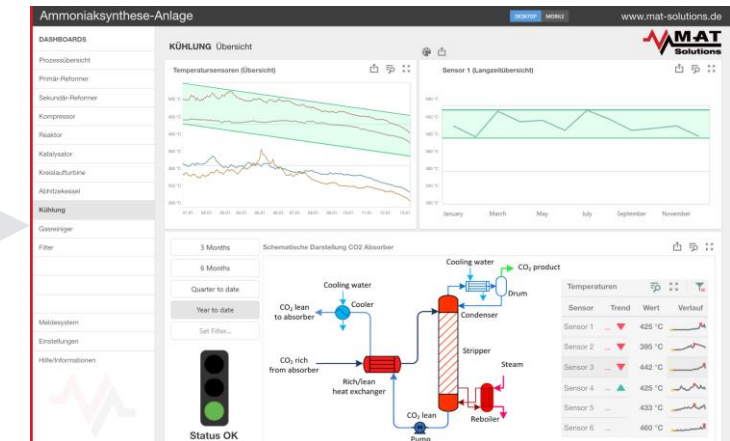
wireless

APC Professional  
Signal processing rules &  
Artificial Intelligence

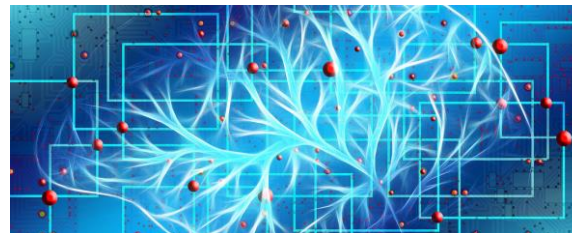


DCS  
with OPC/UA interface

Dashboard



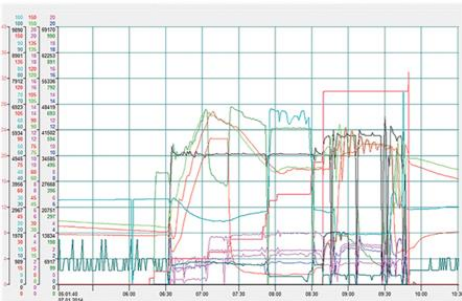
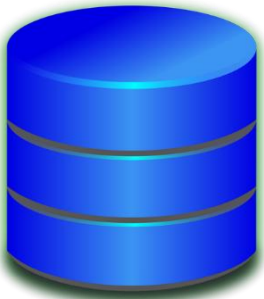
- Early warning of Degradation
- Process impact on degradation
- Recognizes even complex interdependencies



# Approach for Integration of Asset- and Process- Data

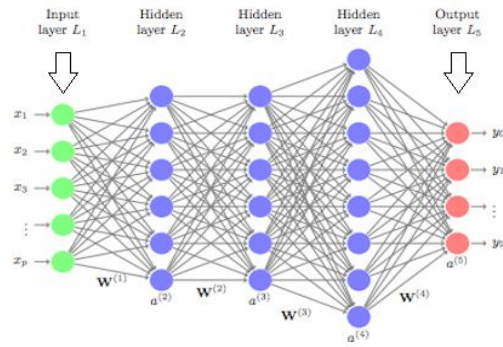
## Relevant Data

- Process
- Plant condition / Degradation



Source: ProLeit, Plant Acquis iT

## Machine Learning (Model formation)



## Optimizer Genetic Algorithm

- proposes Process adaptations
- Alarms regarding Degradation



## Value Generation



Installation: ~6 weeks (optimal Interfaces, conditions & data quality)

# Project sequence

## Preparation

- Selection of monitoring targets
- System limits
- Degradation mechanisms
- Data (from maintenance, Inspections,..)

## Planning & Procurement

- Selection of Sensors
- Installation locations
- Dashboard screens
- Procurement

## Implementation

- Installation
- Training for plant
- Startup

## Monitoring

- Comparisons with Inspections
- Check of AI Models
- Correlation with Process data

- Selecting Problem locations, to be permanently monitored
- R&I, switch plans, plot plan, equipment data,..
- Evaluation of Inspection data
- Insights in Degradation mechanisms for the selection and placement of sensors

- Sensoren installation locations
- Marking on P&IDs, 3D-documentation
- Structure of Dashboard
- Alarm thresholds
- Procurement of sensors and hardware
- Selection of required process data (DCS)

- Installation in the running plant
- Installation during turnaround
- Training of operator personell
- Startup of sensor network, evaluation software, dashboard, AI
- Model formation from process data

- Inspection results are compared with sensor data
- Training of AI models with generated data
- AI uses sensor- and process data to recognize influences on corrosion/degradation
- Generation of informations for the operator, incl. trends, alarms, early warnings



# Examples for permanent sensors

# Detection of fouling with sensors

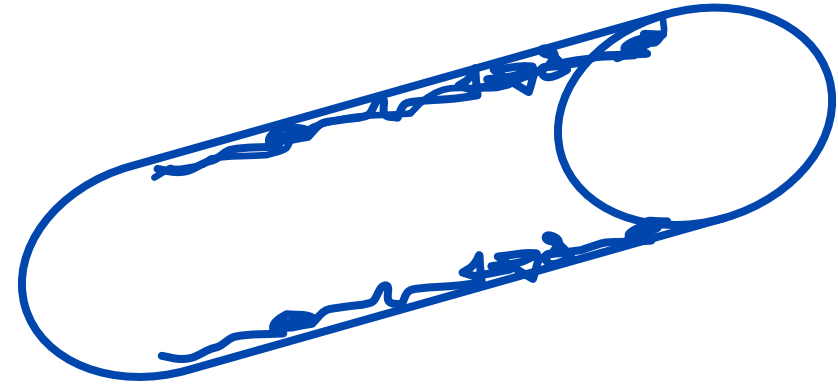
- Fouling in pipelines:

Fouling and deposits are a problem in many production plants for monomers (Acrylics, Isocyanates, Epoxides..) and Polymers (Polystyrene, Elastomers,..)

- Sensors:

Special wall thickness sensors can detect and monitor growth of layers

Another possibility is the calculation from process data (Softsensor)



# New Pipeline or Asset installation

- Description of the issue:

Pipeline / Asset owner knew where to expect strong degradation spots

- Solution:

Selection of sensors which fit to that type of degradation and installation during the construction phase, monitoring 24/7 for years

Corrosion trends and dynamic 'FitForService' on a monthly basis





# Pitting as unexpected type of degradation mechanism

- Description:

An operator found internal localized corrosion (pitting) during an ILI run and decided the segment of the pipe needed to be replaced. The location of the localized corrosion was unexpected and the severity of the pitting a major concern.

- Solution:

Permanently installed areal sensors of type matPIMS with matrix configuration and 24/7 monitoring of the integrity for years



# Atmospheric Gas-Oil Line Monitoring

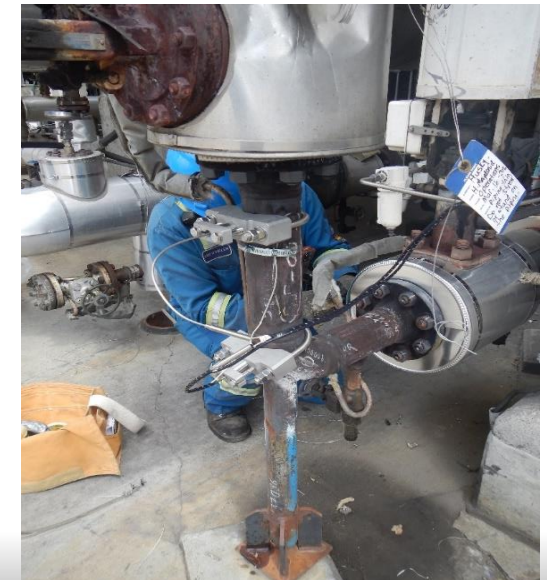
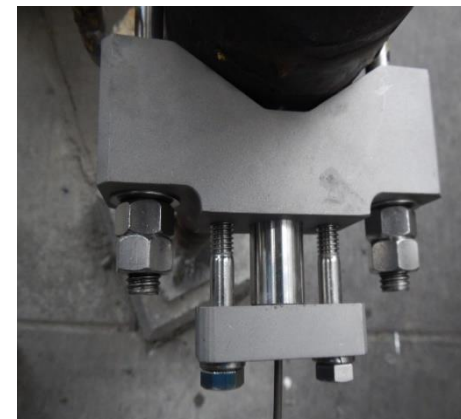
## ■ Description of the issue:

Operator wants to have appealing arguments to show the regulators that he should get plant life extension or extension of the inspection period.

For that purpose the operator must provide prove that he has the asset under control either by non-intrusive frequent inspections with regular None Destructive Testing or:

## ■ Solution:

Permanently mounted sensors in prioritized areas (identified with the support of RBI experts), monitoring of corrosion trends and dynamic FitForService on a monthly basis







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## AMAS Asset Monitoring AI Supported

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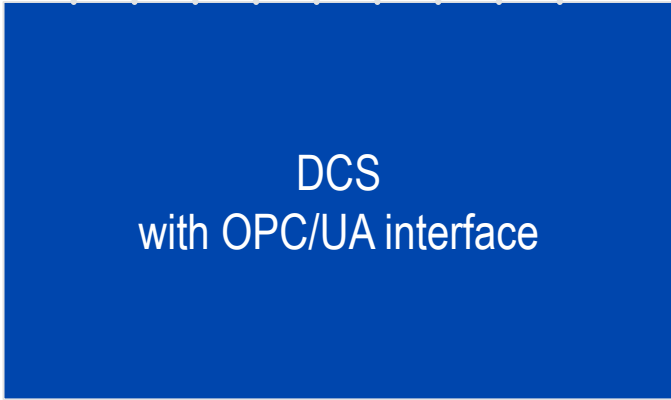
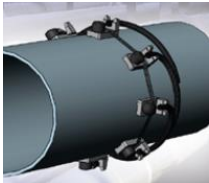
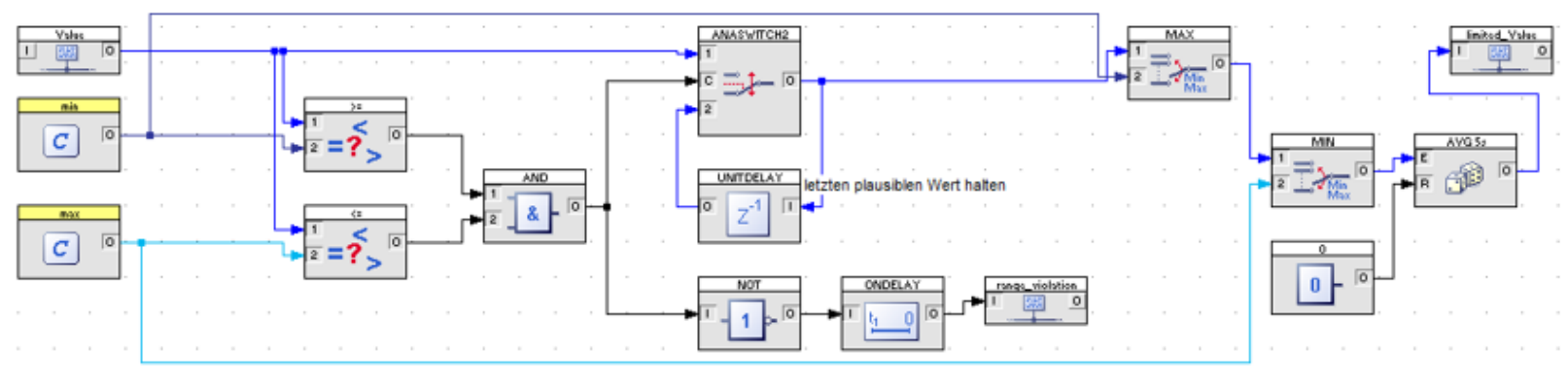


# Example: Dashboard + Interfaces + Sensors

## Dashboard



## APC Professional



Wireless Netzwerk mit Sensoren