Welcome to the Webinar

“Intelligent Monitoring Systems for Machines and Assets”

All attendees microphones are muted for the entire webinar session. Be sure your speaker is active and join the audio conference.

If you have a question, please send it to the host using the “Q&A” function.
Questions will be answered at the end of the presentation.

Presenter - Michael Guckes

- Product Manager Industrial Electronics and Smart Measurement Solutions
- Product manager for industrial amplifiers and software
- Graduate engineer
- 20 years of experience in factory automation
- E-Mail: michael.guckes@hbkworld.com

Michael Guckes

Agenda

- Why Inline-Monitoring of Machines and Constructions (Assets) ?
- What benefits does high-quality measurement technology bring ?
- How do "smart functions" support Asset-monitoring ?
- Modern monitoring concepts and efficient diagnostics - applications
- “Smart Monitoring” – What do we win ?
- A look how we can proceed in an economic way - LIVE demo

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Why Inline-Monitoring of Machines and Constructions (Assets)

Main Tasks

- Improving standard maintenance and inspection by condition-based maintenance
- Fatigue monitoring, lifetime prediction
- Optimize design and support cost effective solutions

What are the benefits of Asset Monitoring?

- Boost lifetime and safety
- Optimizing maintenance process
- Detecting damage in early stage enabling proactive response
- Extension of major overhaul cycle
- Save costs and time
- Better insights

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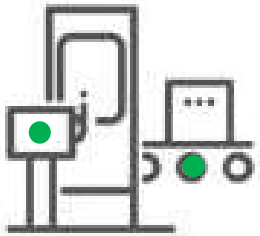
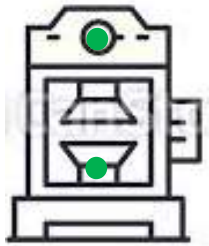
Field of applications

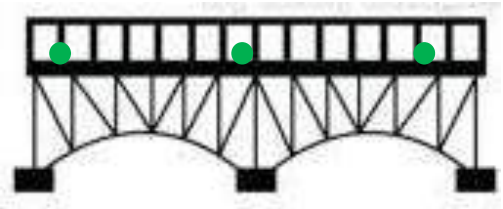
All Machines, Structures !



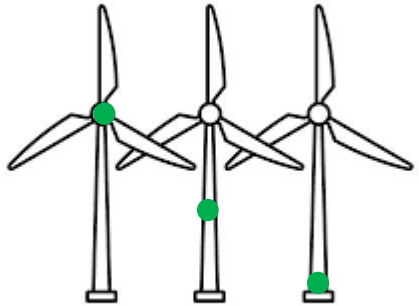
Process



Industry



Buildings



Energy

whether bridges, wind energy plants, water, gas and oil pipelines, tunnels, oil rigs, rails, but also production-lines, machines, assets…

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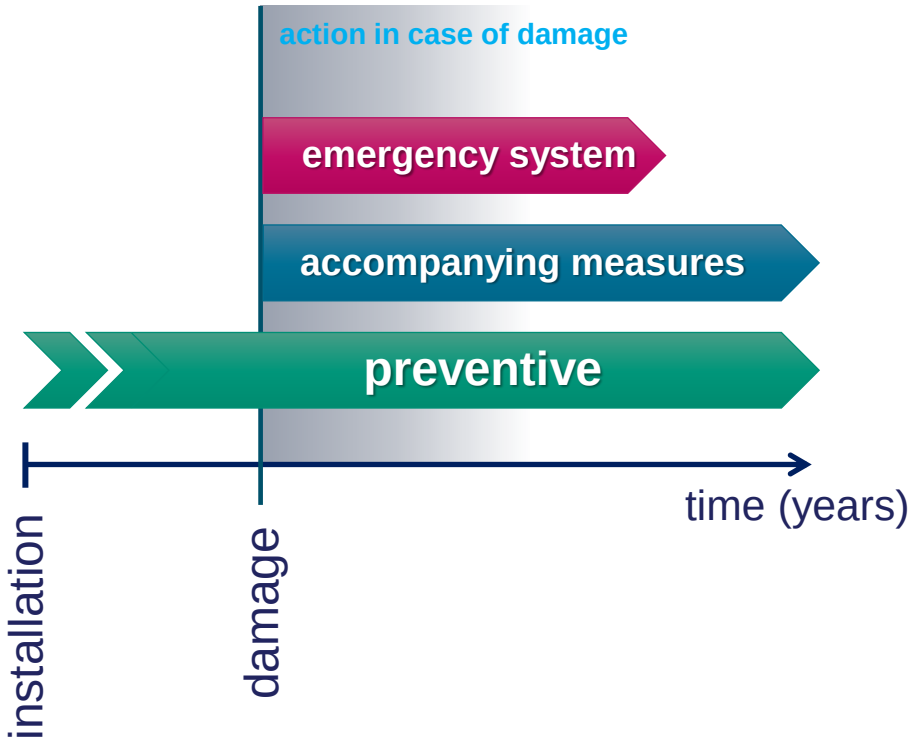
Monitoring - reasons



The argument that monitoring is just a nice to have, too expensive, and not really a core requirement, dissipates quickly when a critical infrastructure or big machine is damaged.

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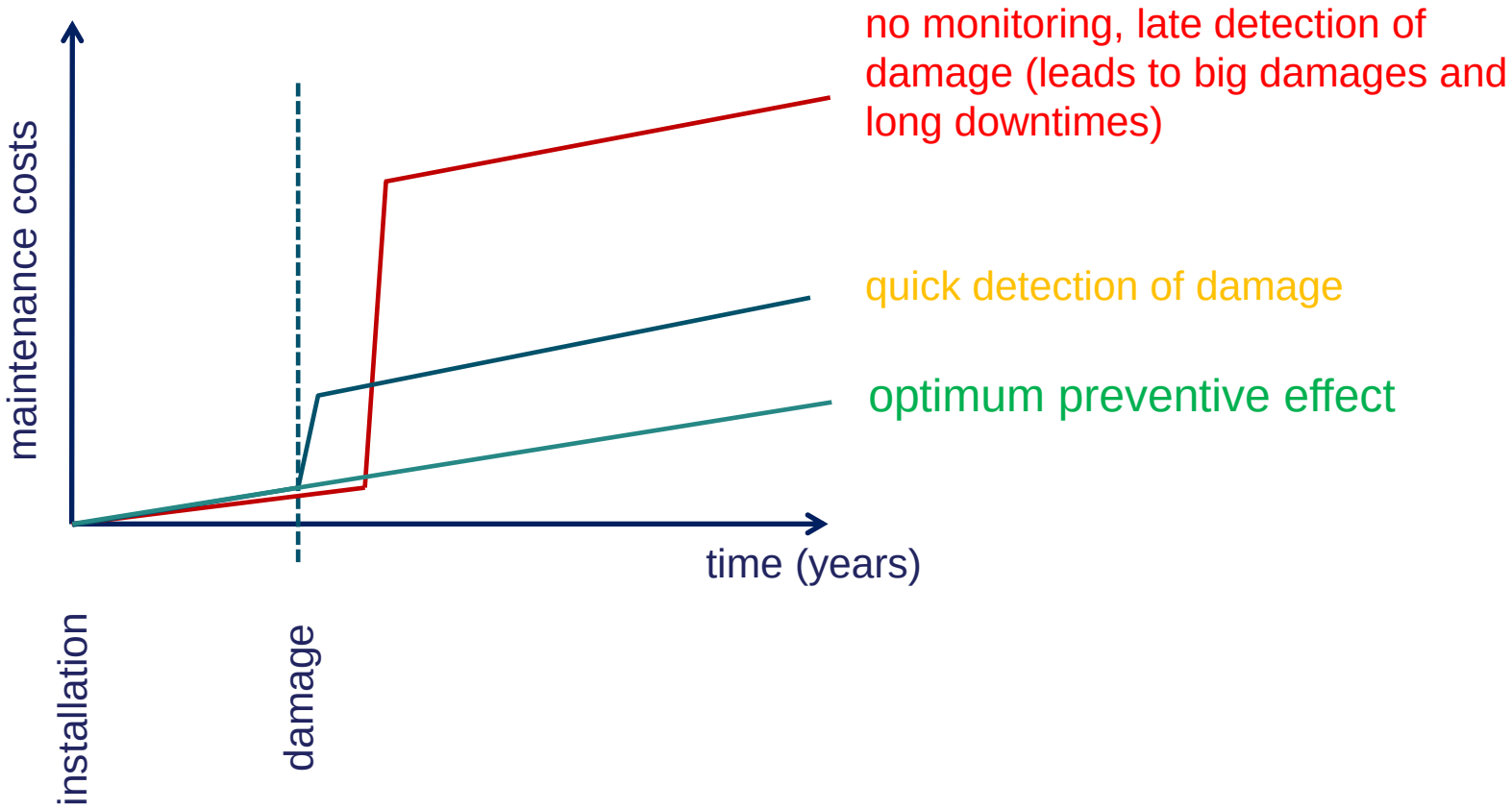
Monitoring - benefit



Note: Monitoring also changes behaviour of users (like a speed camera)!

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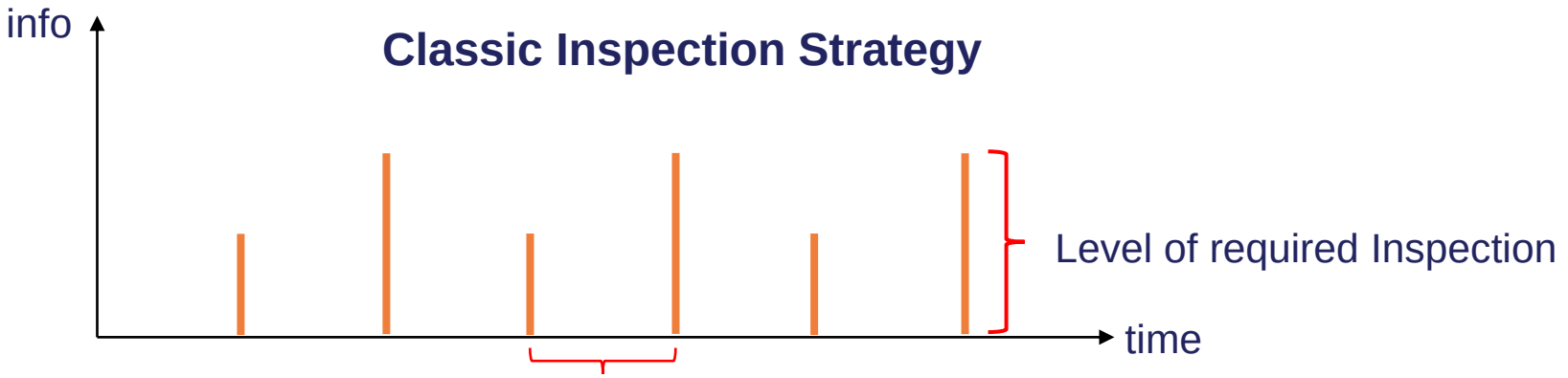
Reduce inspection effort

Periodic inspection is supported by Monitoring Solutions!



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Classification

Long-Term **Structural Health Monitoring**

- Collecting data of several constructions for years continuously (fix installation / asset)
- Structural health is calculated in a post process
- Fatigue performance

Short-Term **Structural Load Acquisition**

- Temporarily installed instruments acquiring the current load condition of a structure and its components for several months

.

What do both type of applications have in common?

- Need to support a wide range of sensors measuring strain, acceleration, displacement, temperature, inclination, ….
- Often distributable instruments / modules
- Powerful data recorder (on-site / off-site)
- Unattended data acquisition with highest reliability
- Central server based integration: remote access, FTP services, push notifications, security, …

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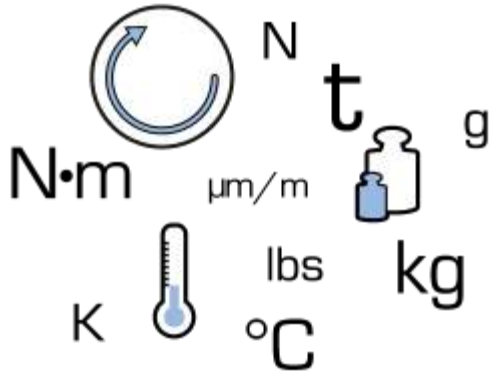
Typical sensors in monitoring applications

Deflection, stress, movement and torsion

- foil strain gauges (set up in quarter, half, or full bridge strain configurations), Carlson strain meters inclination, vibrating wire strain gauges
- Inclinometers, extensometers



Displacement

- inductive half bridge, LVDT
- joint and crack sensors, tilt sensors
- electronic barometric level

Ambient conditions

- Temperature, humidity, atm. pressure, rain, ice, wind speed / direction

Dynamics - acceleration, calculated speed, ground motion

- current fed piezos (IEPE), piezo-resistive bridge, MEMS
- capacitive, active (0…20 mA, 0…10 V)
- borehole accelerometers
- servo force balance accelerometers

Noise and Video

- noise emission, field acoustics with microphones
- Picture, video (example: heavy load passing the bridge -> picture of the vehicle)

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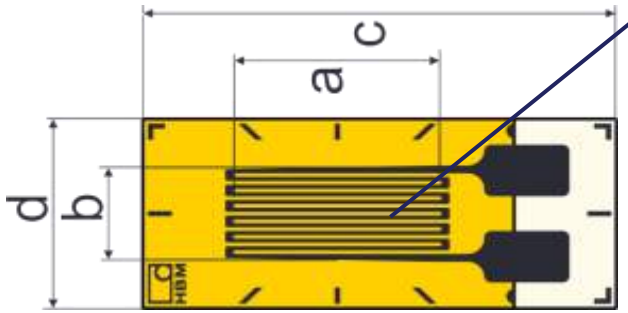
What benefits does high-quality measurement technology bring

Conventional technologies

- Strain gauges

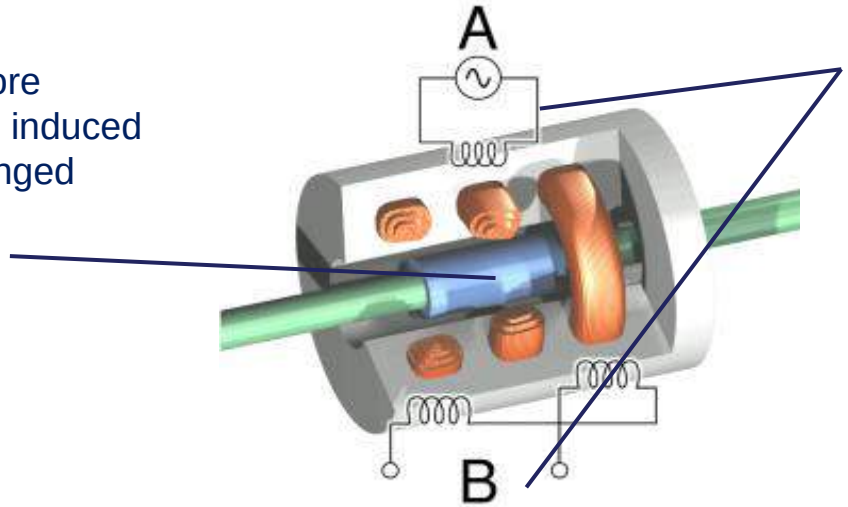


Metallic foil -> when deformed changes its electrical resistance

$$\frac{\Delta R}{R} = k.\Delta\varepsilon$$

- Inductive

Ferromagnetic core
-> when it moves induced voltages are changed



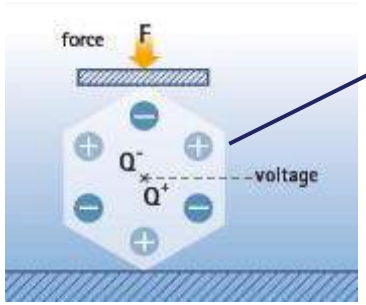
Induced current is driven through a primary coil causing an induction current on the secondary coils.

$$d = G.\Delta V$$

Available technologies

Conventional technologies

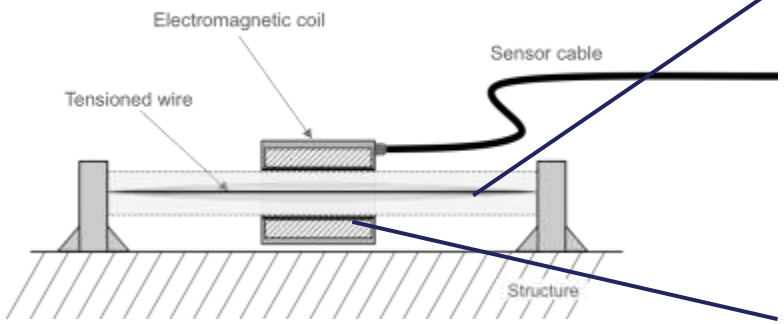
- Piezoelectric



Cristal -> under compressive loading generate an electric charge

$$Q = q_{11}.n.E.A.\varepsilon$$

- Vibrating wire



Tensioned steel wire -> when stressed its vibrating resonant frequency changes

Electromagnetic pulses are sent causing the wire to vibrate. The resonant vibration induces a current back.

$$\varepsilon = k.(f_0^2 - f^2)$$

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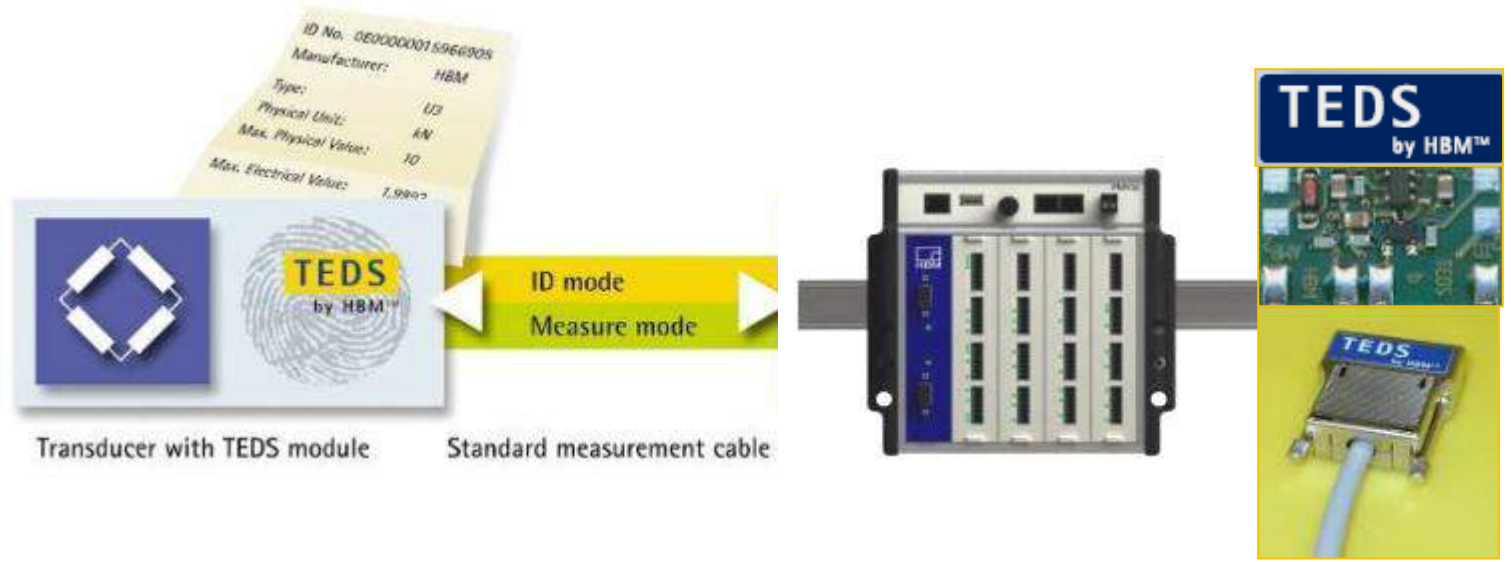
TEDS - Immediate usage of evaluation criteria

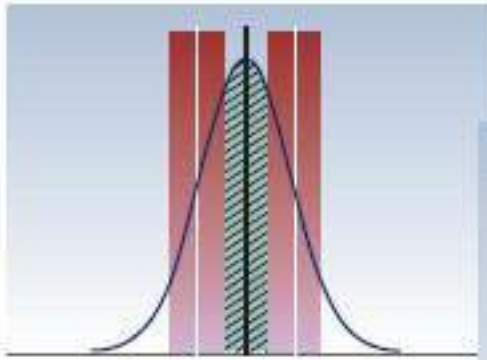
TEDS by HBM™ → Plug & Measure



Performance, Accuracy, Measurement Uncertainty – Why?

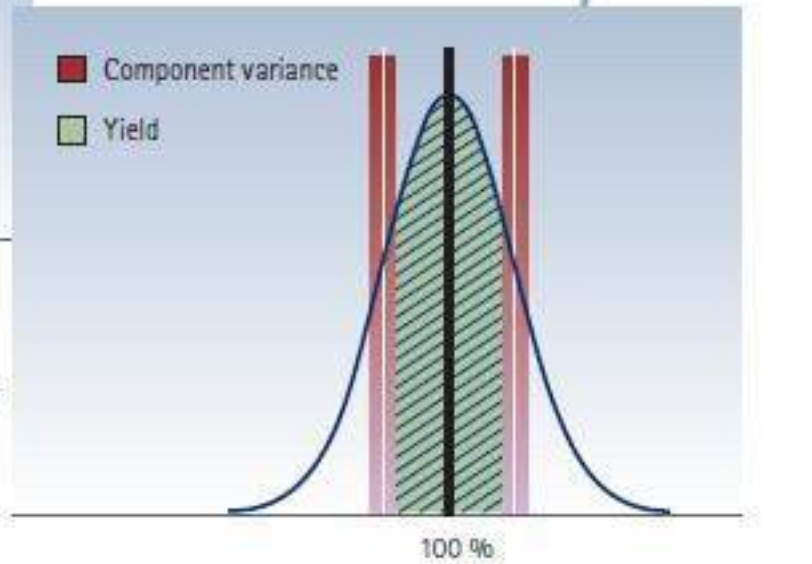
- Greater accuracy makes it possible to record manufacturing tolerances more precisely.
- Components are precisely tested and manufactured with the necessary tolerance.
- Reduces rejects and conserves resources while maximizing output.

...without



Process monitoring with conventional measuring amplifiers, high rejection rate due to measuring inaccuracies

... with



Increased efficiency with PMX, optimum yield with precise measurement results

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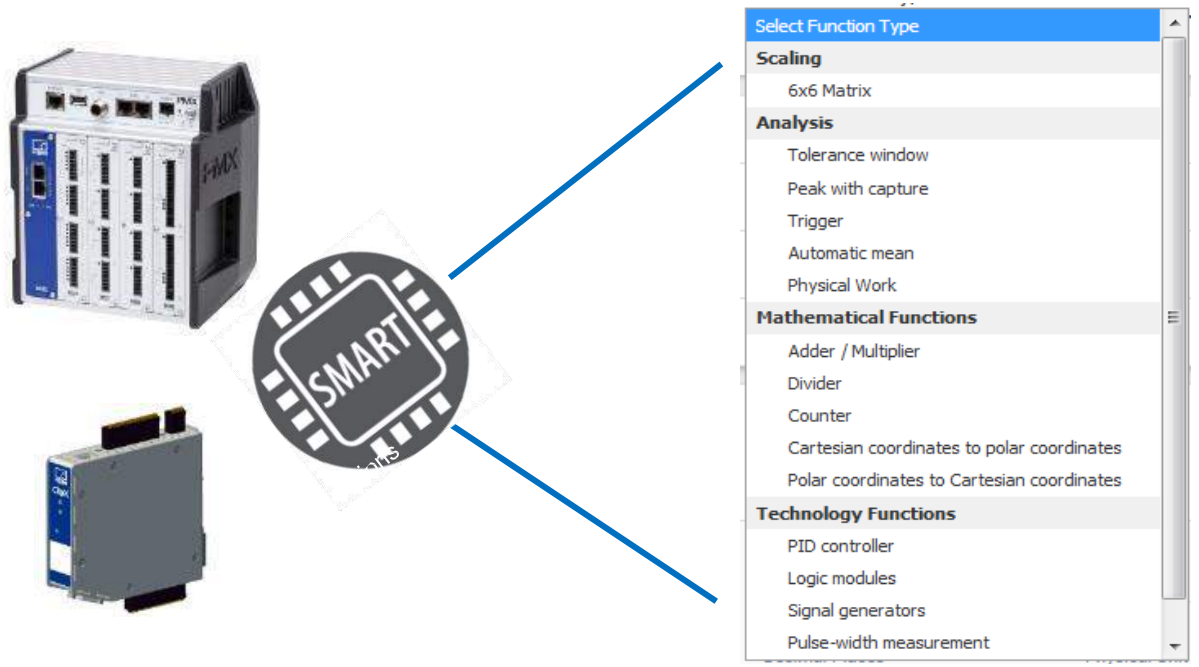
How do "smart functions" support Asset-monitoring

Automation with Calculated channels



- A lot of **applications require additional signals/ information and calculations** coming from the measuring signal .e.g.: Peak, Mean, math. logic functions, timer, counter, PID regulator,..
- Combinations are possible, Calculation speed is **52us** for each channel, easy setup via Web-GUI

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New edge solutions support data analysis

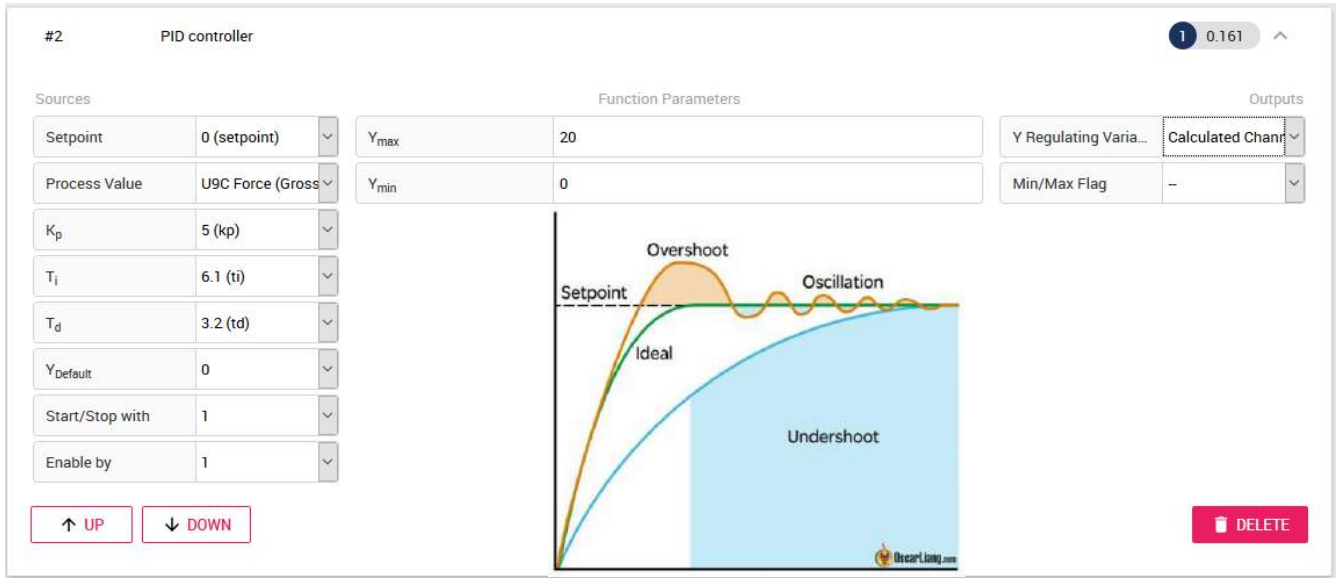
Intelligence in the measurement components

- Change from programming to parameterization

  Pre-implemented logic: PID - controller

```
0001 IF switch = TRUE THEN
0002     devSpeed:=T#10ms;
0003 ELSE
0004     devSpeed:=T#25ms;
0005 END_IF
0006
0007 IF devTimer.Q THEN
0008     devTimer ( IN := FALSE, PT := devSpeed );
0009     engine := NOT engine;
0010     IF engine = FALSE THEN
0011         steps := steps + 1;
0012     END_IF
0013 ELSE
0014     devTimer ( IN := TRUE, PT := devSpeed );
0015 END_IF
```

Software program code



Pre-implemented calculated channel in the edge controller

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Modern monitoring concepts and efficient diagnostics - applications

PMX live-demo: http://pmxdemo.hbm.com

PMX adjustment and monitoring

- Easy adjustment via integrated Web-Server
- Parameter set storage in PMX
- Online diagnostic via PMX device status and channel status
- Data logging on site for service or via Web-Server on remote stations

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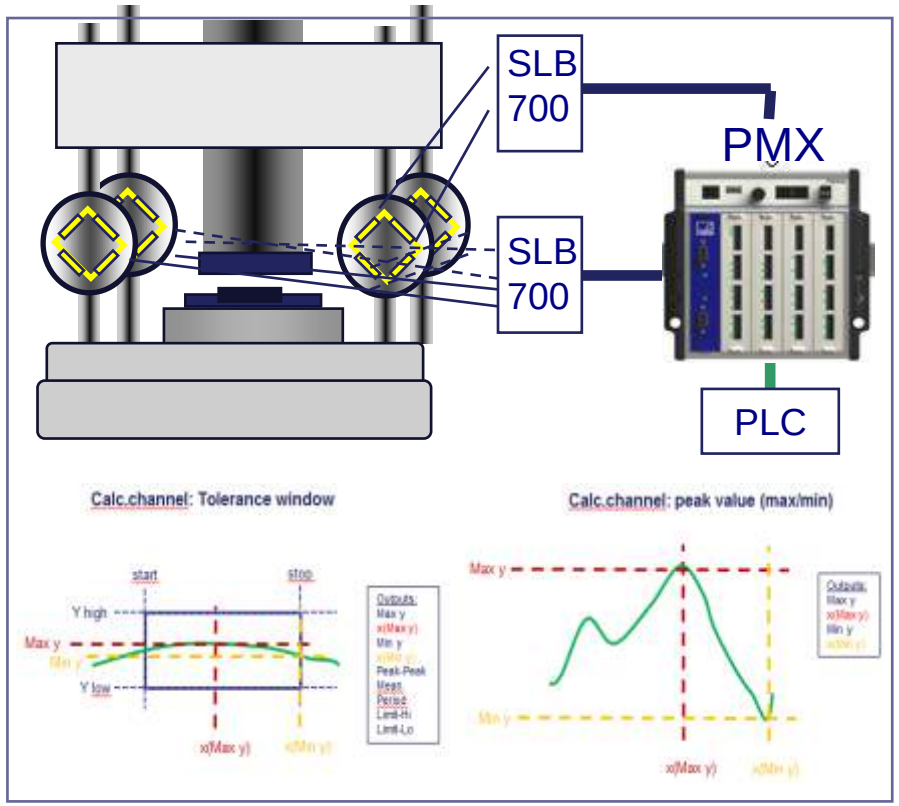
Press load monitoring in hot-forging presses



Industry compliant measurement technology:

- 50 to 150 strokes/min in 2 or 4 column design. 2 Strain sensor SLB per column
- Fast limit value outputs of PMX increase machine protection (tolerance, alarms, counter)
- Adaptation to the common machine network over fielbusses
- Analog output signals and data-storage (PC or PMX) for service and maintenance

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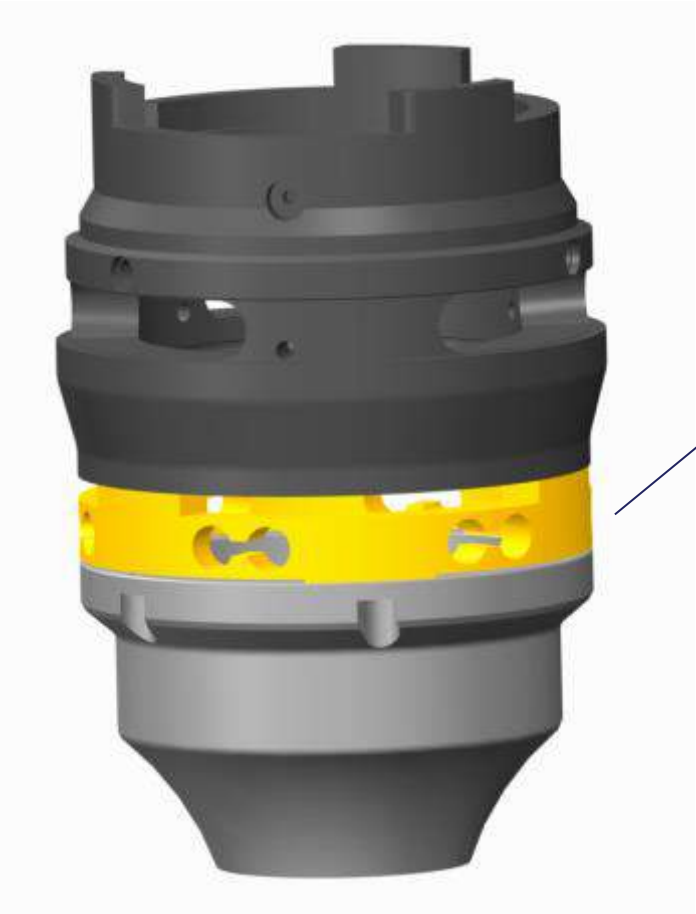
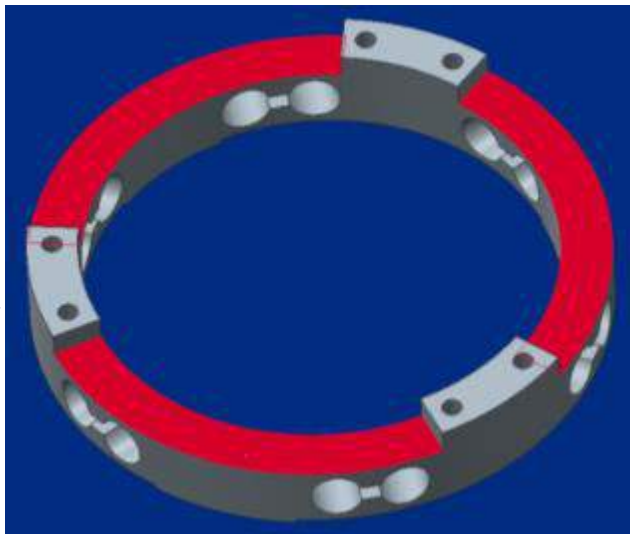
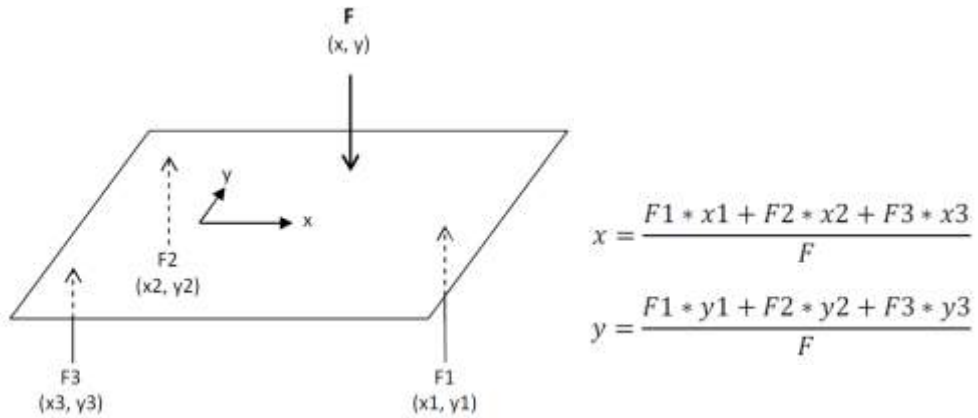
Application in medical machine control

Medical Eye-Laser treatment



Sensor





$$x = \frac{F1 * x1 + F2 * x2 + F3 * x3}{F}$$

$$y = \frac{F1 * y1 + F2 * y2 + F3 * y3}{F}$$

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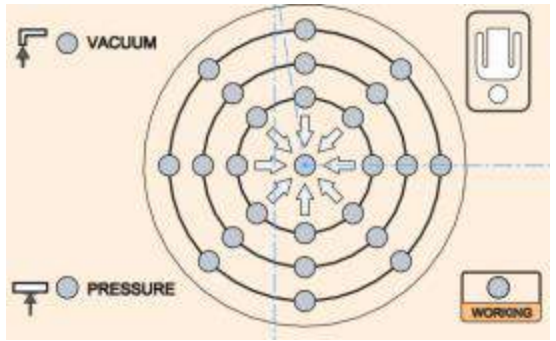
Application in medical machine control



Laser cutting machines for eye lens correction

- Precise and robust force (SG multicomponent) measurements for adjusting the laser optic
- Calculated channels provide polar coordinates of the resulting force as digital and analog output, and can be equipped for redundancy measurements
- Customer gets rid of old and unprecise SG-measurement and increases efficiency of the operation

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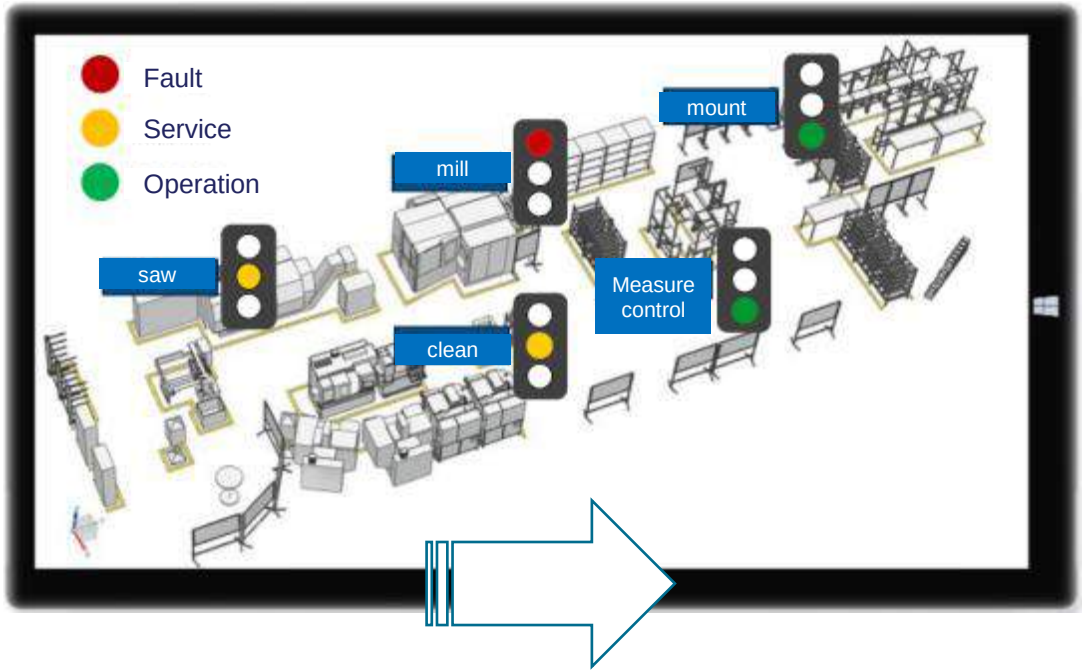
Networked production – “Smart factory”

Model Factory I4.0 Darmstadt University of Technology: manufacturing pneumatic cylinders

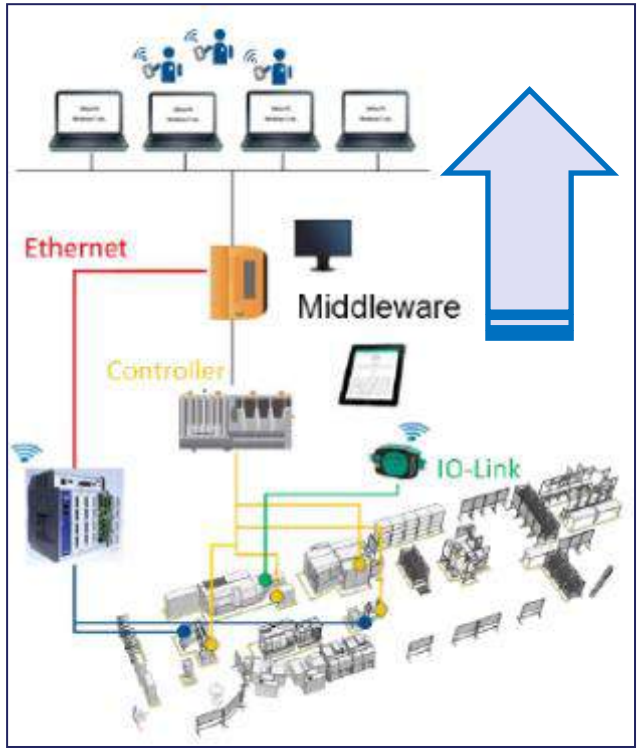


Horizontal integration and flexible worker assistance systems:

- Component as an information carrier by means of RFID chip
- Component and assembly information, employee information
- Linking the data along the value stream
- Energy consumption, quality assessment (pass / fail)

Networked production – “Smart factory”

Model Factory I4.0 Darmstadt University of Technology: manufacturing pneumatic cylinders



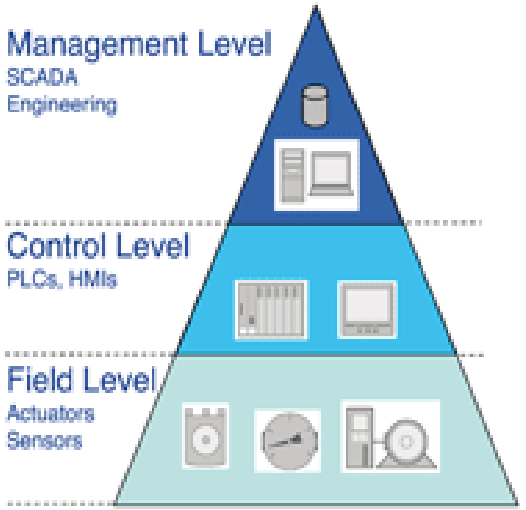
Vertical integration and quality of the machining process

- "Dashboards": product state, process state and machines condition
- Visualization for different users
- Unified data management
- Integration of data from the shop floor through the process tiers

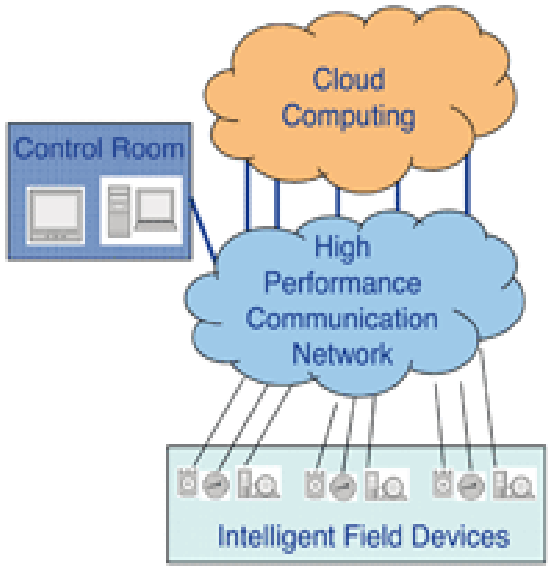
Infolink: http://www.effiziente-fabrik.tu-darmstadt.de/menue/index.de.jsp

Smart Monitoring” – What do we win

Today



Future



Ethernet technology will replace the Fieldbus in the long term

- TSN standard for real-time capable networks
- Communication protocols and the LAN and WLAN interfaces integrated on one system on chip
- High integration on one component lower the costs for an efficient communication connection
- Google Cloud joins the OPC Foundation

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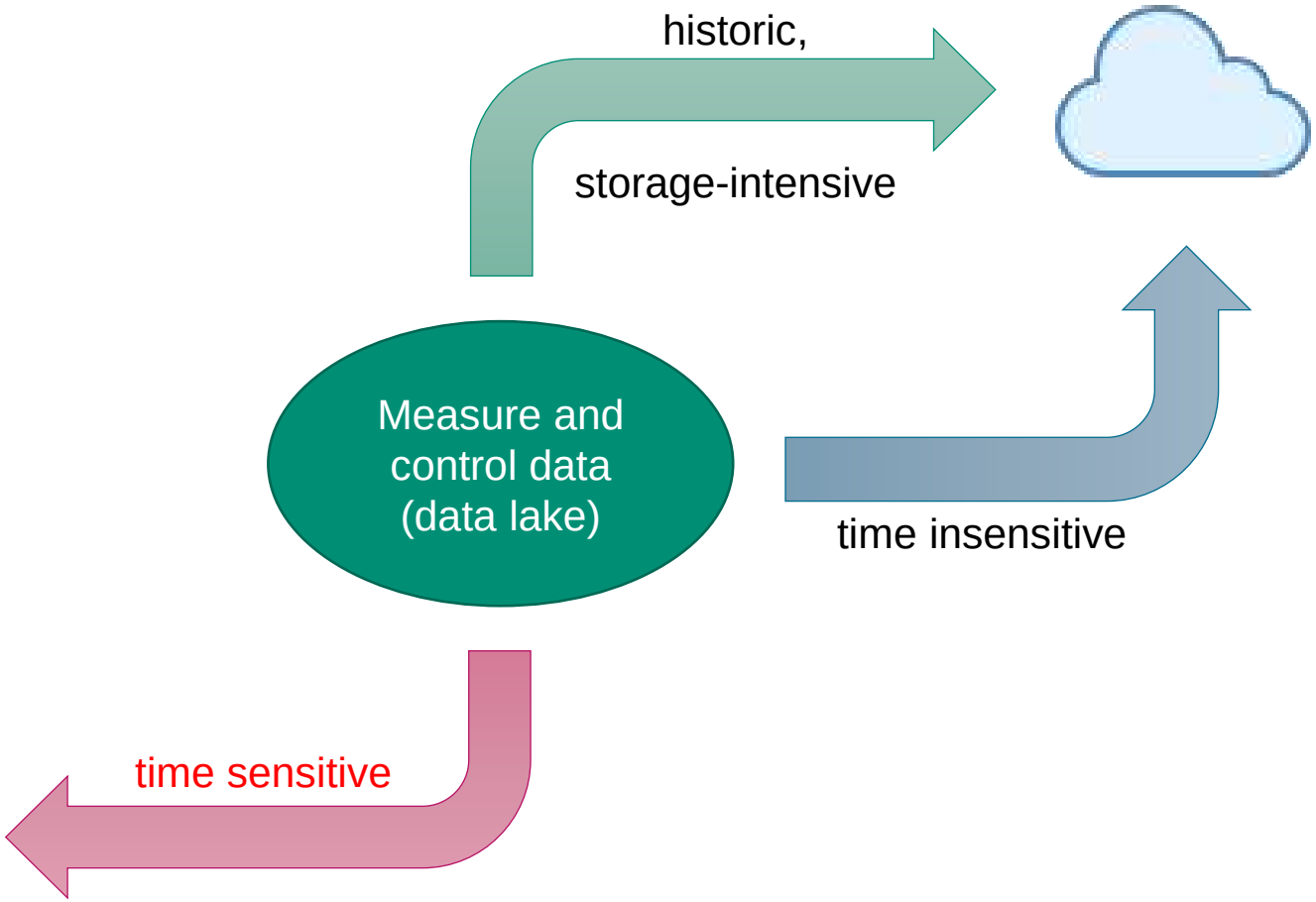
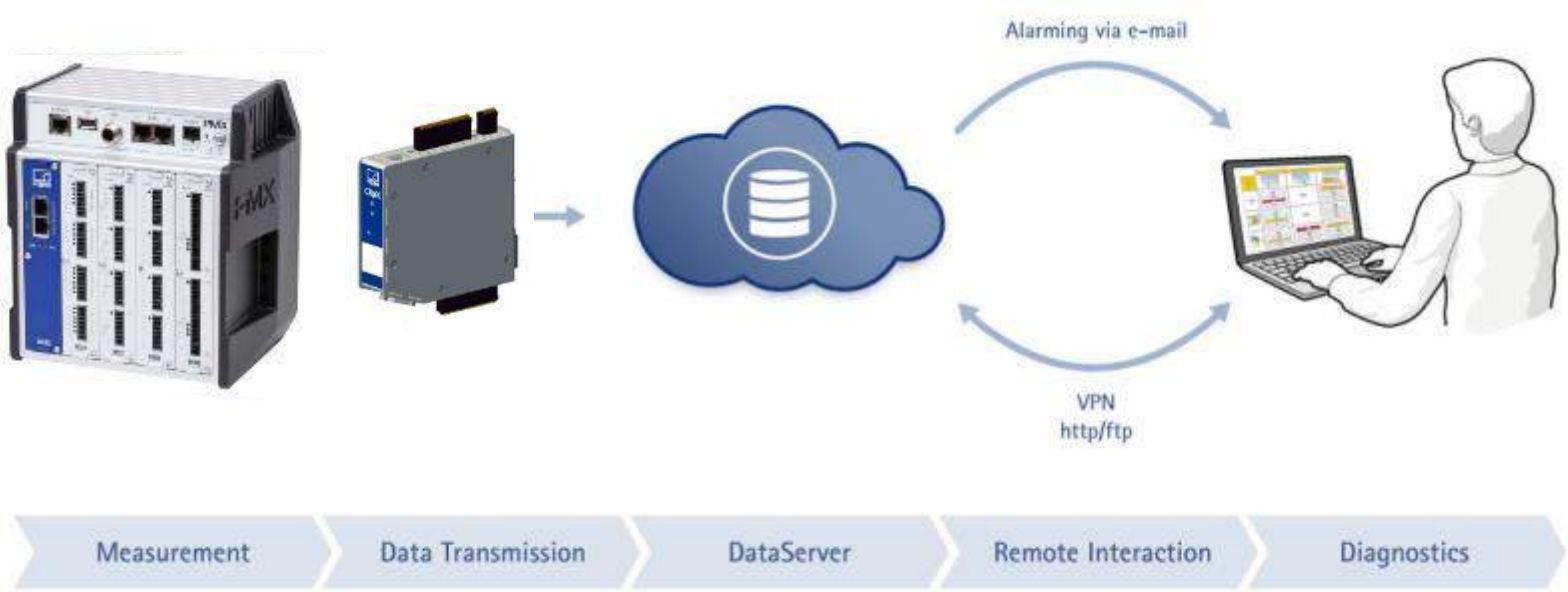
Intelligent hardware – data processing

- Despite cloud uptake – edge computing is essential
- ‘Process data where it is most useful’

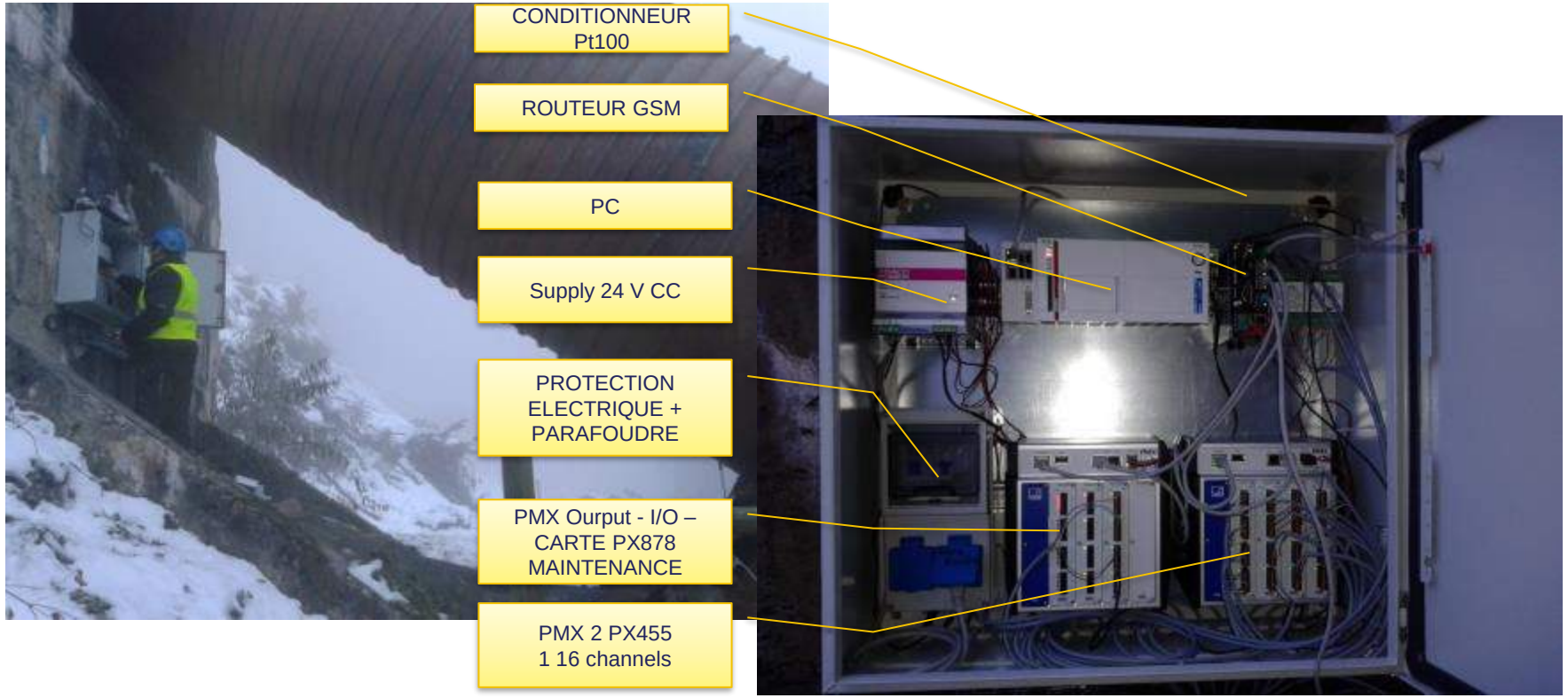


Data storage, processing and analysis

- Automatic Monitoring systems create a large amount of data that is of no use unless it is analyzed
- Data centers for storage
- Automatic processing for data analysis
- Automatic report generation
- Alarm management
- Safe and secure data storage and connectivity

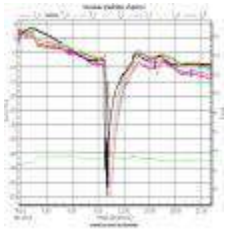


Application in structure monitoring – Pipeline monitoring



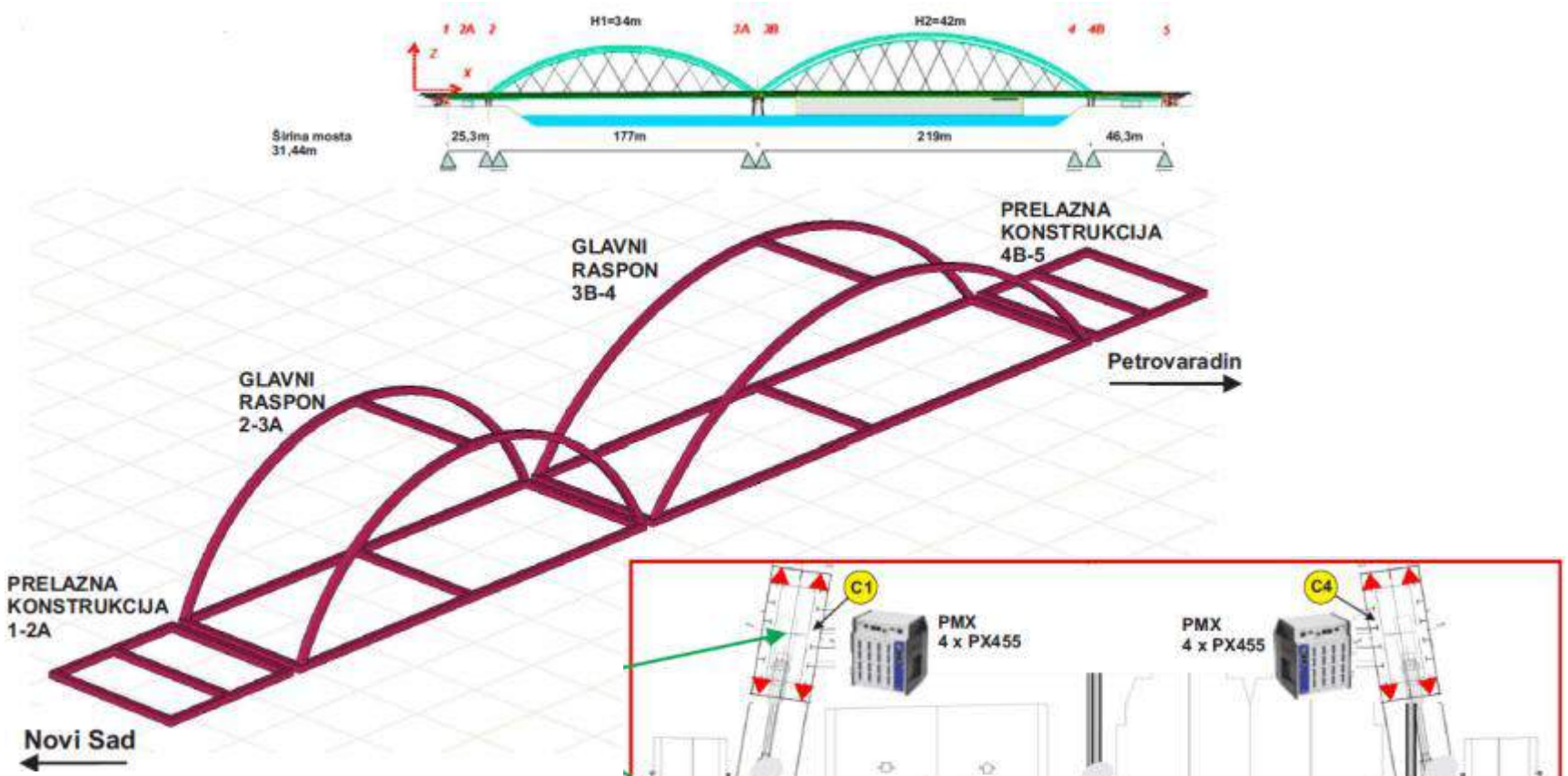
Concept monitoring water power plant

- Measure ½ bridges, temp / Control/ storage
- Online diagnostics via PMX
- Data logging on site for service or via Web-Server on remote stations
- Option VPN-Router: direct messages(SMS) via GSM to smart devices



Bridge monitoring

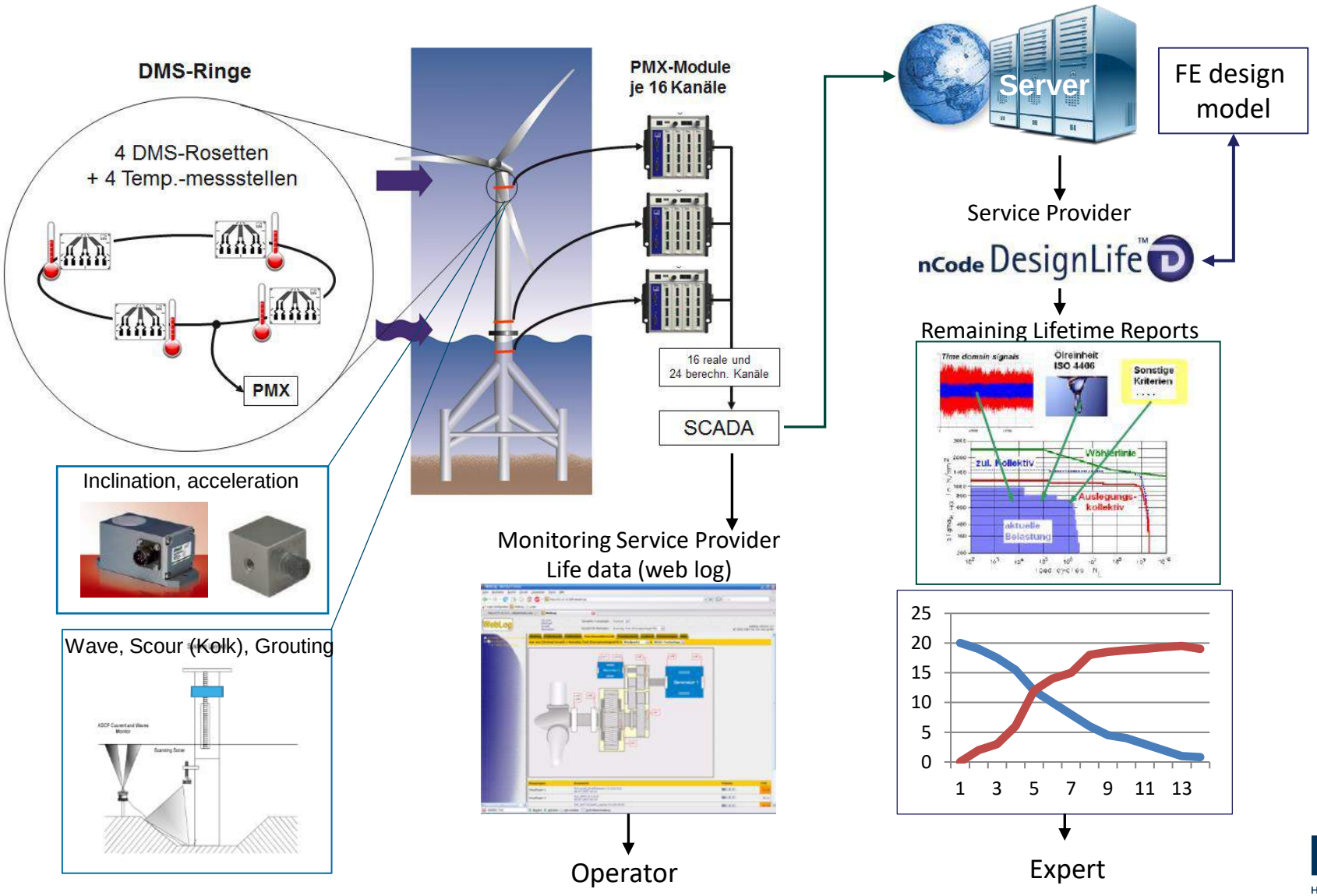
Projekt: new bridge Novi Sad



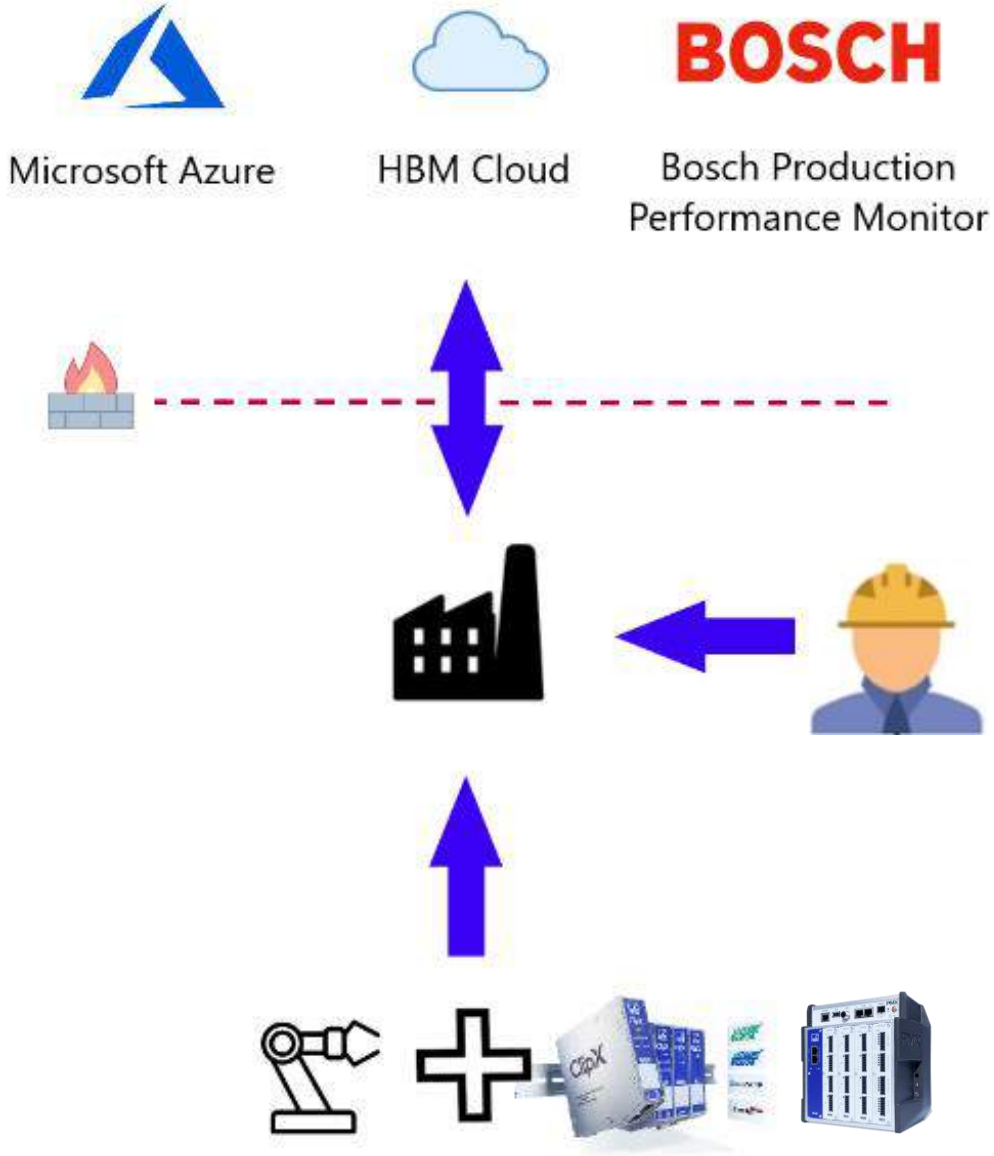
Instrumentation

- 28 PMX with PX455
- SG: LY41 6/129
- WA/50mm-L

Monitoring Solutions – Offshore Wind Energy



A look how we can proceed in an economic way - LIVE demo



Analytics

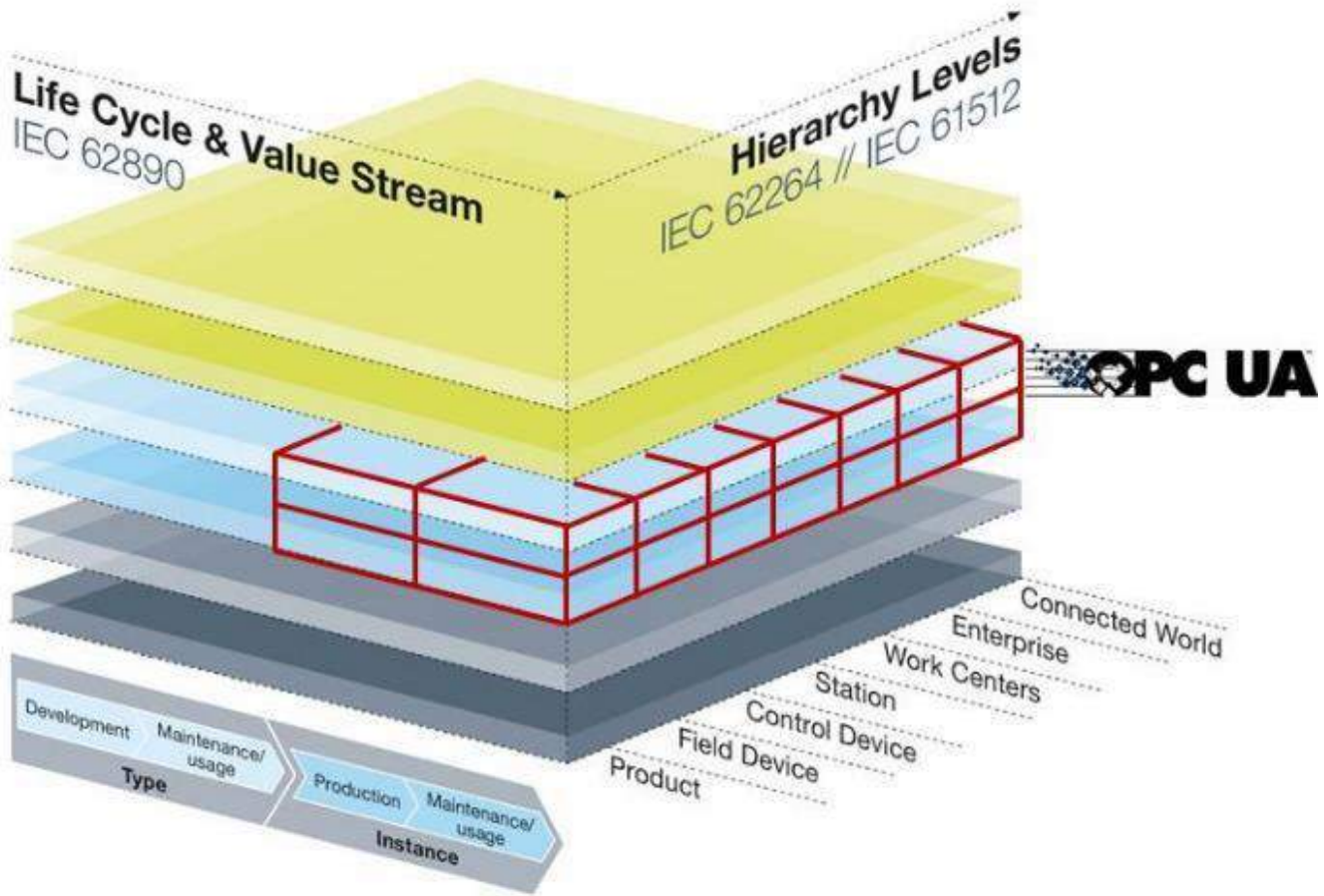
Storage/Logistics

Service/Support

Manufacturing/ERP

Properties of OPC UA

- OPC UA covers a large area of the Industry 4.0 Reference Architecture Model (RAMI 4.0)



IoT protocols

http / REST / PPMP

Client

POST

transmit “all” data, select later
transmit inflated data (http/json)
transmit at a maximum rate

Server

Server

OPC UA

request

response

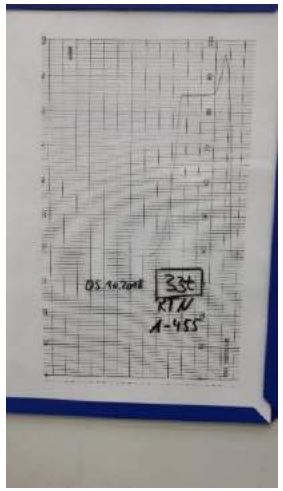
transmit selection only transmit binary
transmit at required rate

Client

OPC-UA / REST application with ClipX (HBM Smart Factory)

Where we all come from

Manually control



Manufacturing of ring torsion load cells

Monitoring of temperature in the ovens

SMART Solution

Automatic acquisition and check by ClipX smart device

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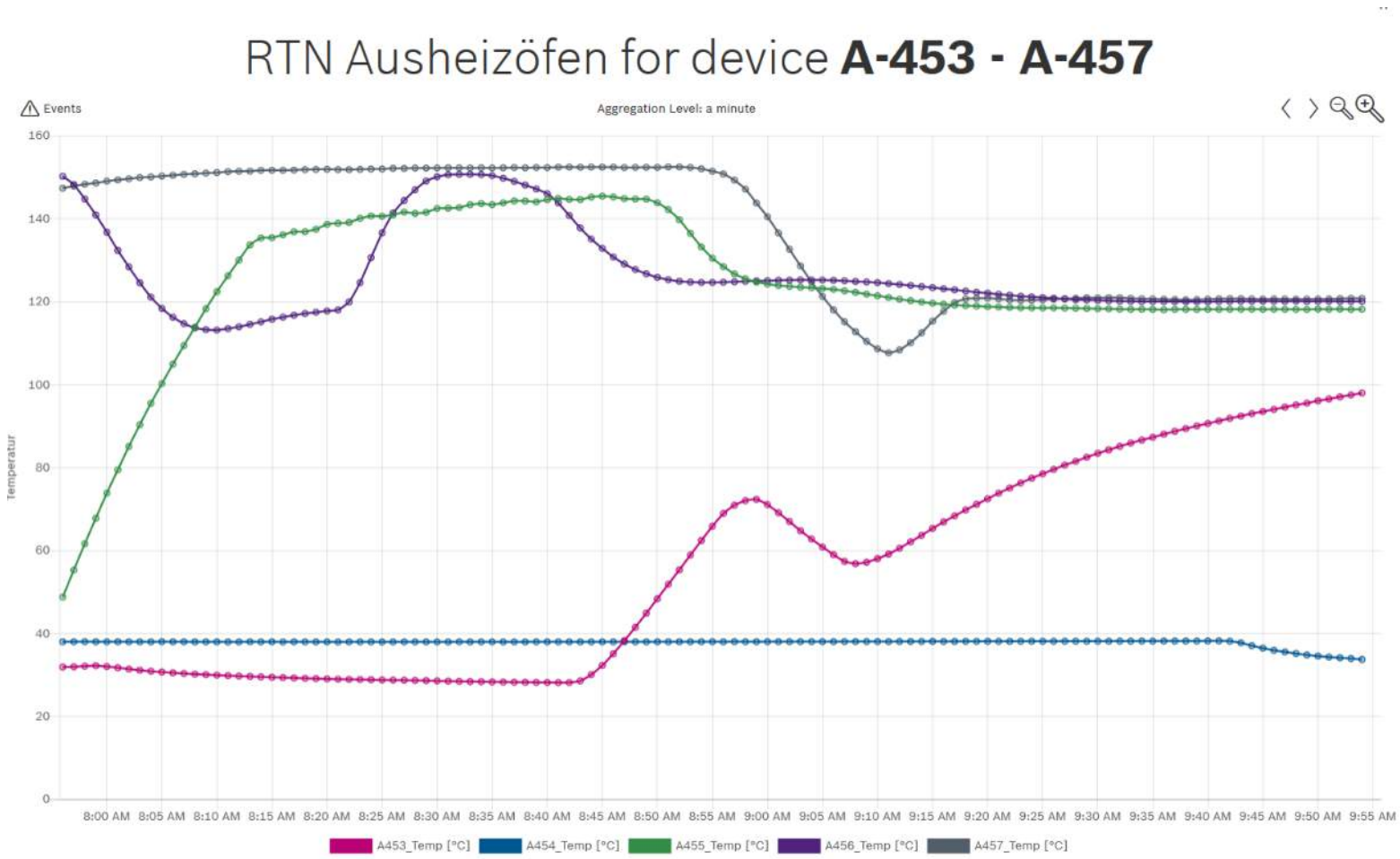
ClipX in application - RTN production at the shop-floor

https://boschiot1.hbmcloud.com/



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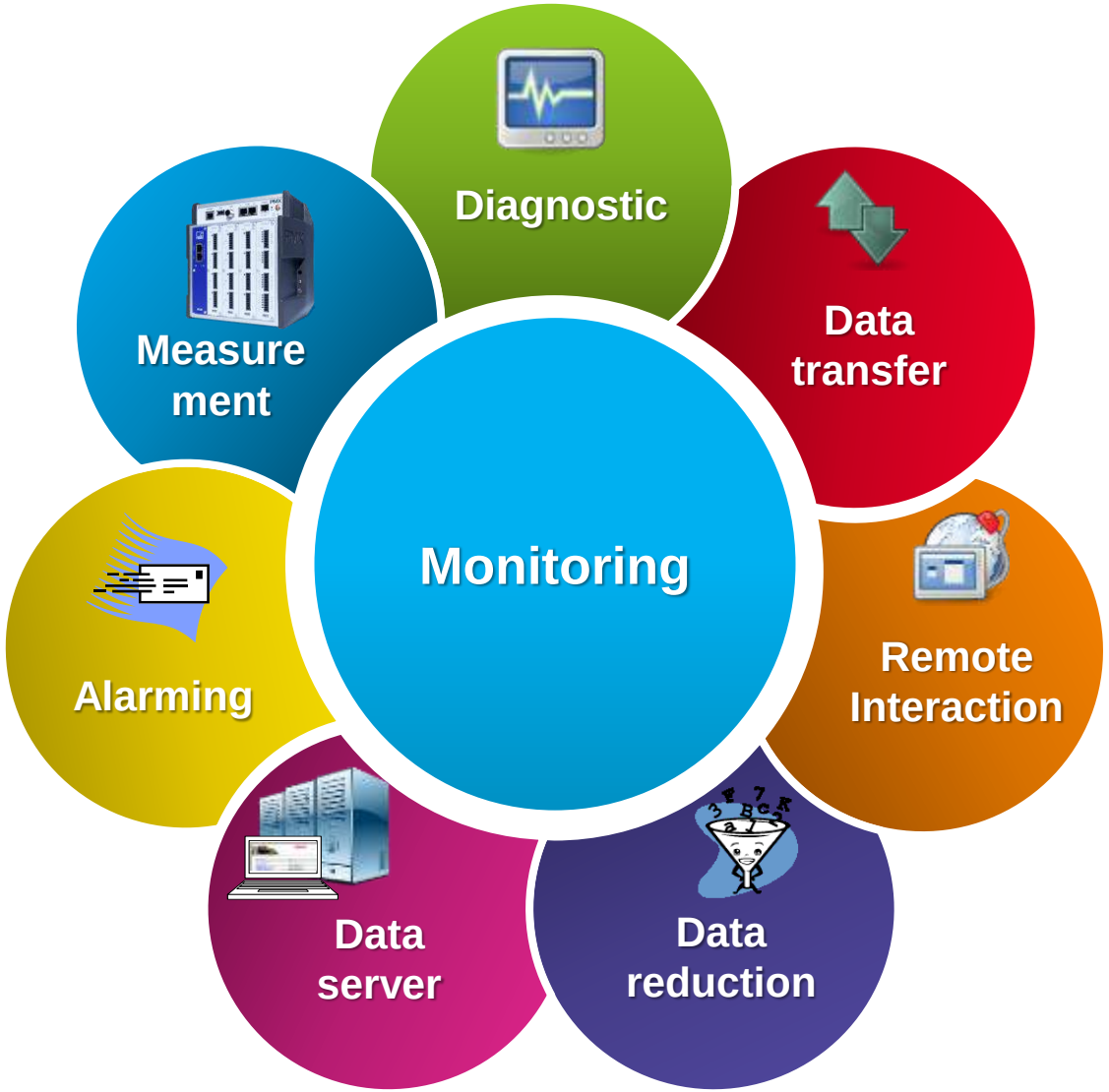
What do we win with Smart Asset-monitoring & IoT



- Intelligent components
- Ensure quality
- Avoid rejects
- Avoid machine downtimes
- Increase transparency in the production

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Thank You

Dipl.Ing. Michael Guckes

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