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Welcome to the “The Challenges of Structural Health Monitoring (SHM)” Webinar

The presentation will begin at 04:00 PM Central European Time | 09:00 AM Central Time | 10:00 AM Eastern Time

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.

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Organizational Information

- All participants' **microphones** are **muted** during the webinar.
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- Today’s presentation will be E-mailed to all attendees. The webinar will also be posted on our website: http://www.hbm.com/en/3157/webinars/
- If you have additional technical questions, feel free to contact our technical support team at support@usa.hbm.com

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- Master level degree in Engineering and Economics
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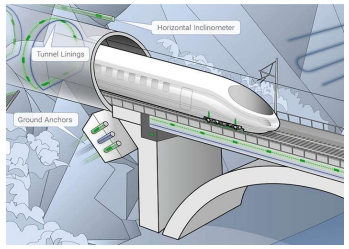

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Typical reasons for Structural Health Monitoring (SHM)

Improving standard maintenance and inspection by condition-based maintenance

- Detecting damage in early stage, enabling proactive response
- Optimizing maintenance process
- Extension of major overhaul cycle

➢ **Lower costs, higher availability**

Fatigue monitoring, lifetime prediction

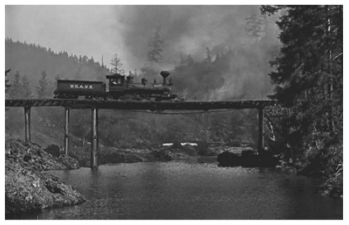
- Boost lifetime and safety
- Optimize design and support cost effective solutions
- Continuous observation and data (for new projects)

➢ **Better insights, better product development**

Identification of critical situation

- Immediate reaction

➢ **Safe lives, avoid breakdown**



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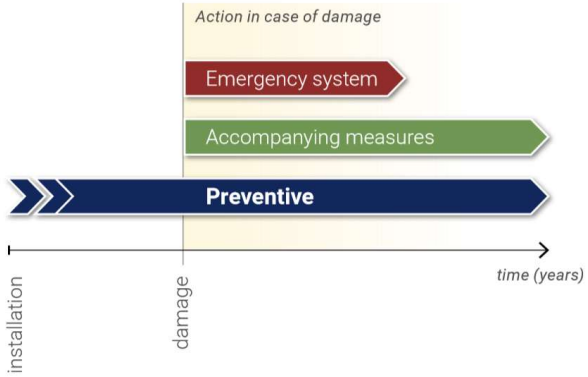
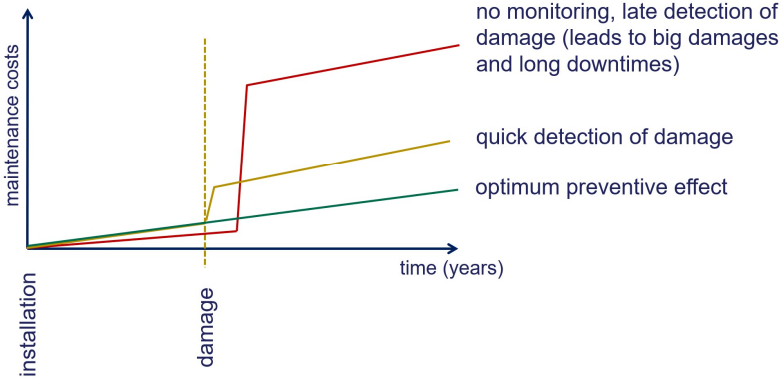
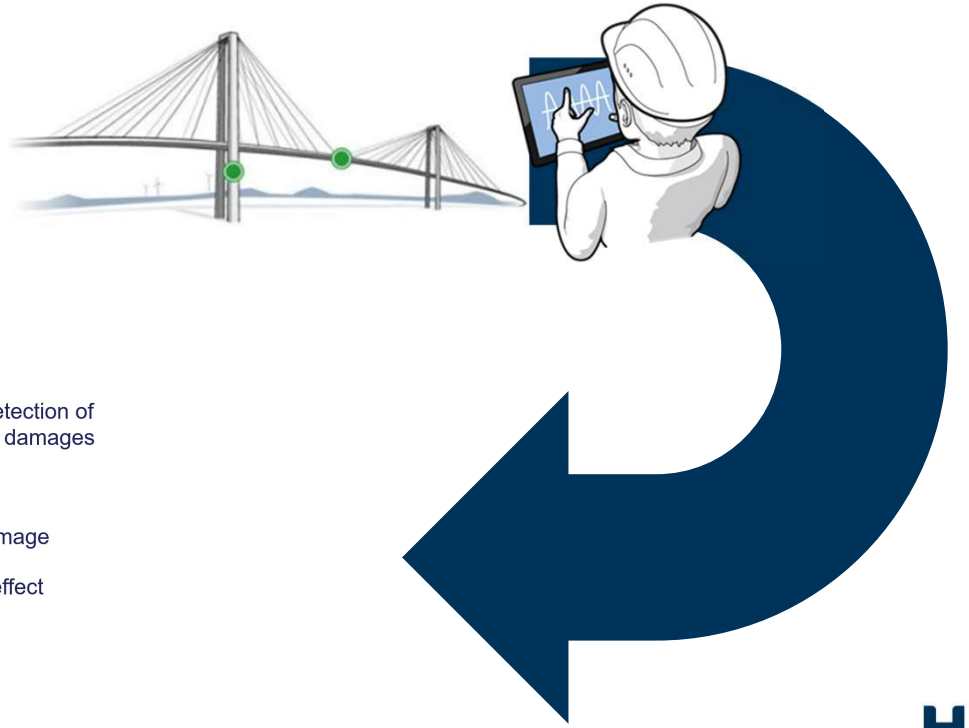
Gaining Real Insight into a Structure's Health







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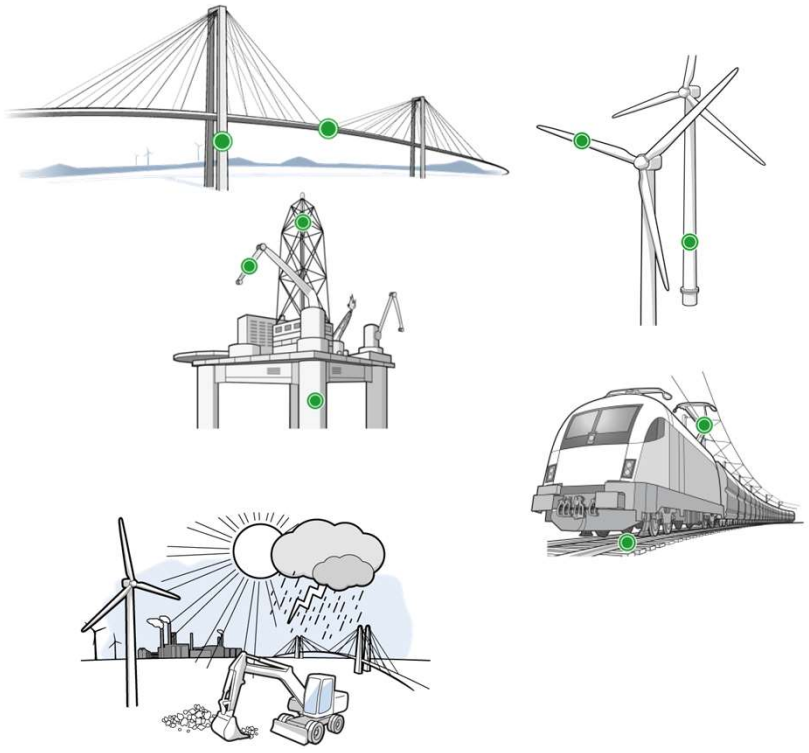
Challenges

Prerequisites for trustworthy forecasts/decisions

- reliable data
- high signal quality
- long term stability and durability
- data integrity (time synchronized data)
- extraction of the essential information needed for
  - immediate reactions
  - maintenance decisions
  - the prediction of lifetimes

Typical constrains

- Size of the structure, long distances
- Harsh environmental conditions
- remote location, slow data connectivity
- data transfer
- data management and storage (data lake)



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Overall solution concept

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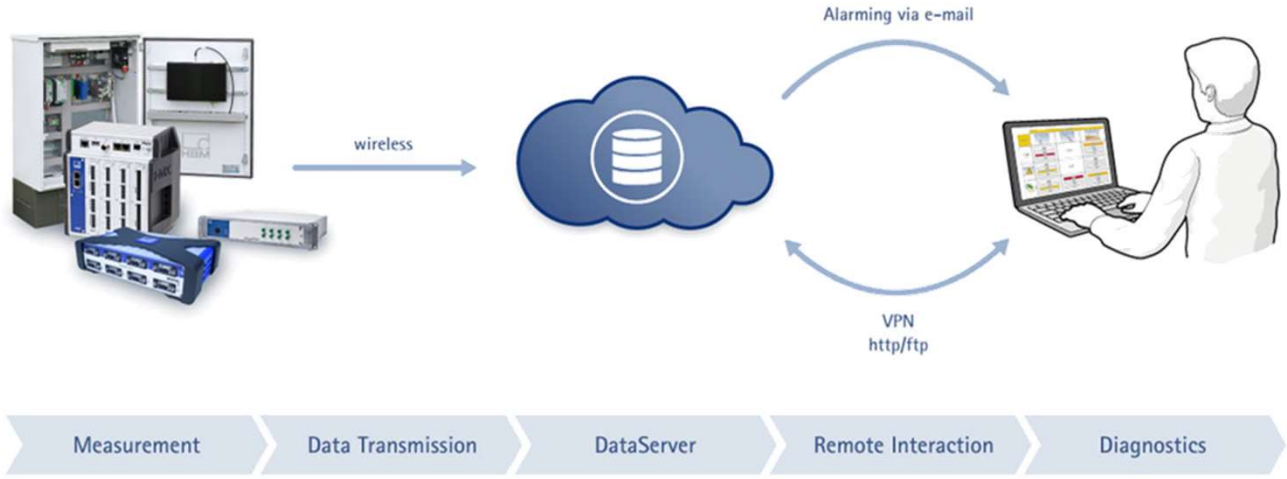
Ideal solution?

- There is no ideal/standard solution
- Every SHM needs a **case by case analysis**

➔ **reason for HBK modular approach**



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Standard approach – useful for most projects

Amplifier

universal

rugged

fibre optical

- Logging
- Intelligent triggering
- Preprocessing / Edge computing

processing

- ftp/sftp
- cloud connect

Reports

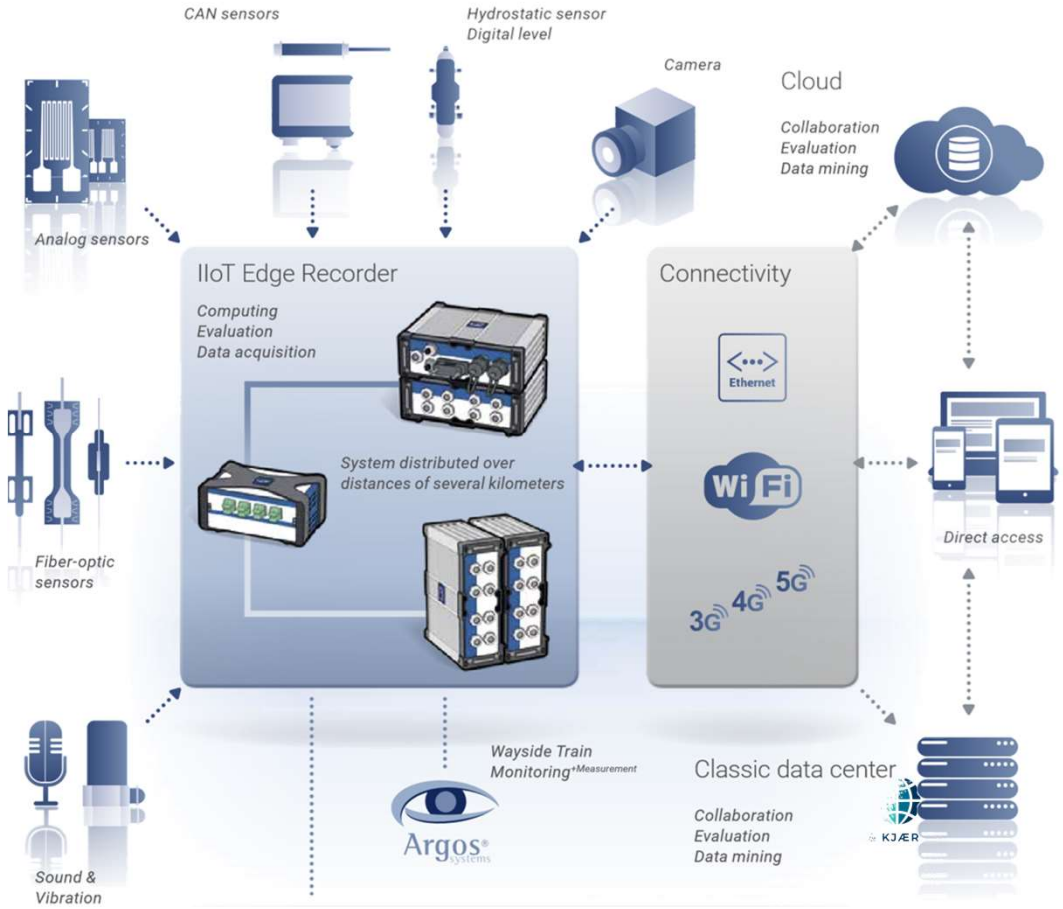
HBM push notification

Alert via E-Mail

Credits: graphic generic mobile by Matt Jones

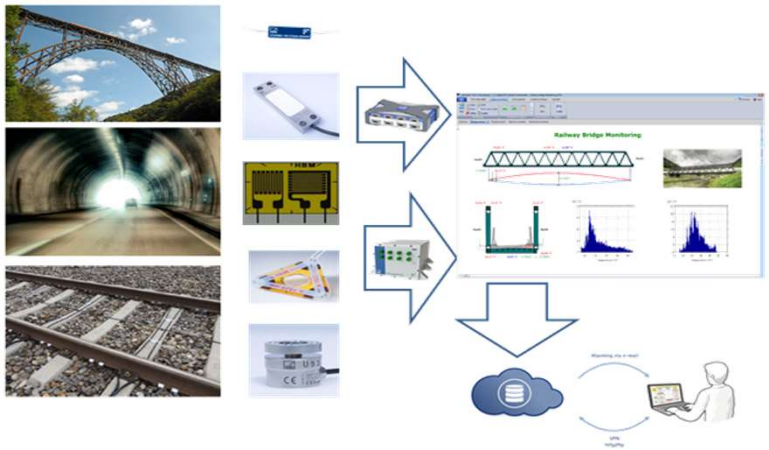
Wide sensor range, distributed over distances

- Wide range of physical and digital inputs
- hybride fibre optic sensor system
- Ultra-robust (vibration, shock) according to MIL-STD202G
- Extended temperature range: -40…+80 °C, dew-point resistant
- Dust- and water-proof with ingression protection grade IP65 and IP67
- Fire protection rating according to DIN EN 45545-1:2013
- Reliable design offering 10,000 plug cycles
- Distributed system, Time-synchronized data



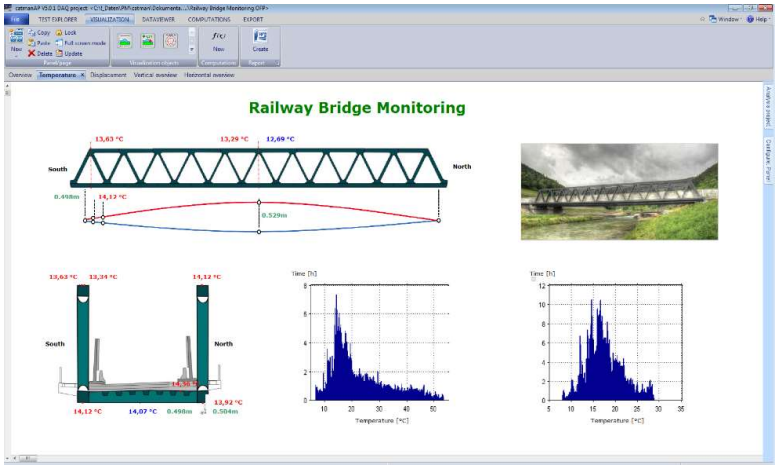
HBK solution set

- Components (sensors, DAQ – QuantumX, PMX, FS22 software – Catman, nCode, Reliasoft)
- Cabinet equipped with components incl. startup and software (modular set)
- Custom solution incl. cloud, on-site sensor installation and service



Out-of the box: Data logger functionality for Monitoring

- Take long-term measurements over several days, weeks and months
- Easy setup of hybrid systems (electrical and fibre optic sensors mixed)
- Carry out parallel data acquisition jobs using a single data recorder (individual files, triggers)
- Data classification - Rainflow, FromTo, etc - direct in Logger
- Save data locally or automatically transfer data to FTP servers or the cloud
- Implement automated actions and alerts such as smart phone push messages or/and E-Mails triggered by defined events
- Integration of weatherstation signals
- Live data visualization in the Web using Microsoft Power BI
- Event and status logging



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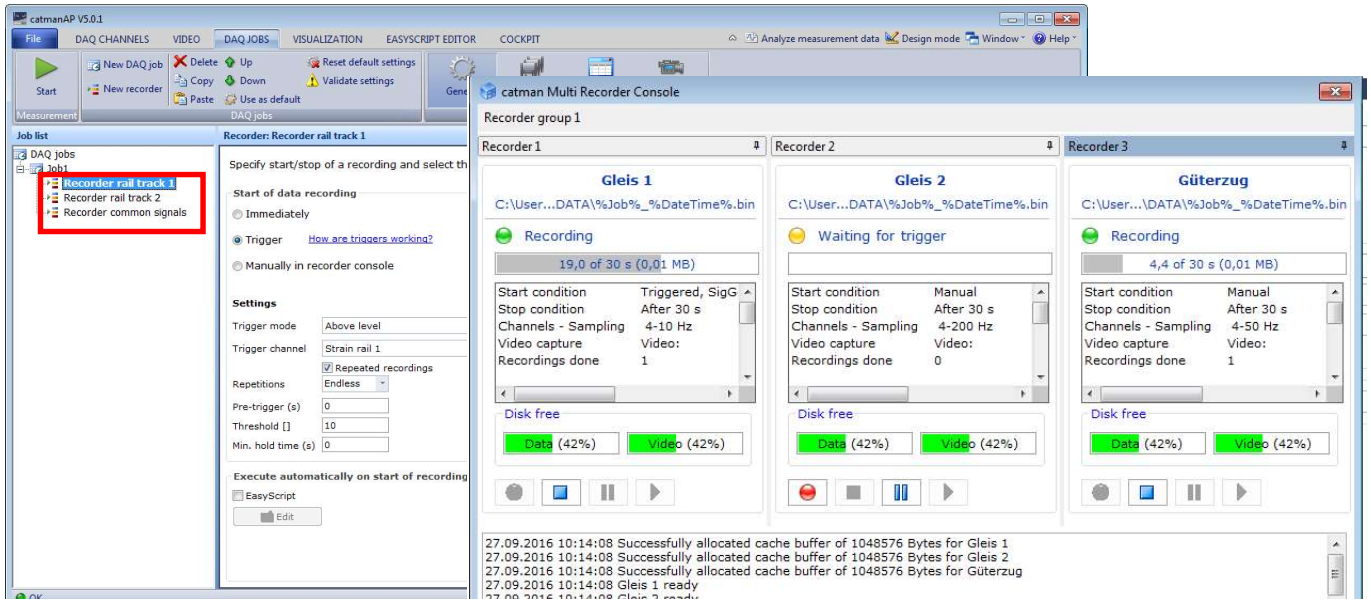
Parallel Recording - Define several recorders within one DAQ job

- Recorders are running **in parallel** (max 15)
  - Each recorder can have a individual **subset of channels** with **own sample rate**
  - **Separate** start/stop condition
  - Individual files per recorder
  - By default recorders are repeated endless



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Statistic journal for parallel long term measurement

- Statistic journal can be used to do long term DAQ **in parallel to** triggered measurement
  - Use Case: “load events” (crossing train, heavy vehicle, storm) all inputs are acquired with high sample rates (triggered) in parallel to constant time recordings (7 hours / 365 days) for slow moving structure
- Saves Min, Max, Mean in separate bin file
- Works independent from DAQ trigger (optional)
- Wide range of update interval (sample rate): 5s .. 24h
- Configure time interval for file creation
- Available in DAQ job settings

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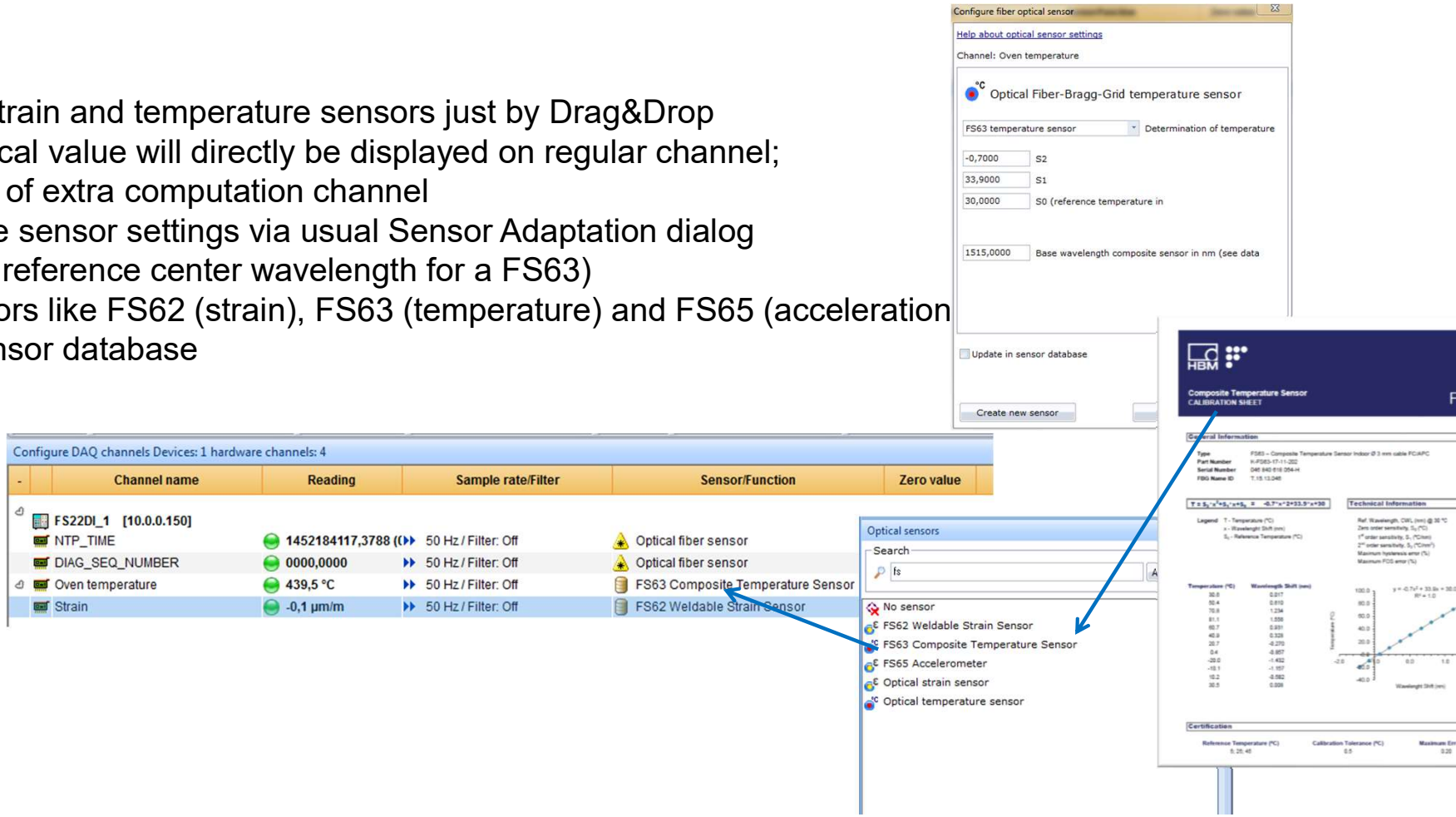
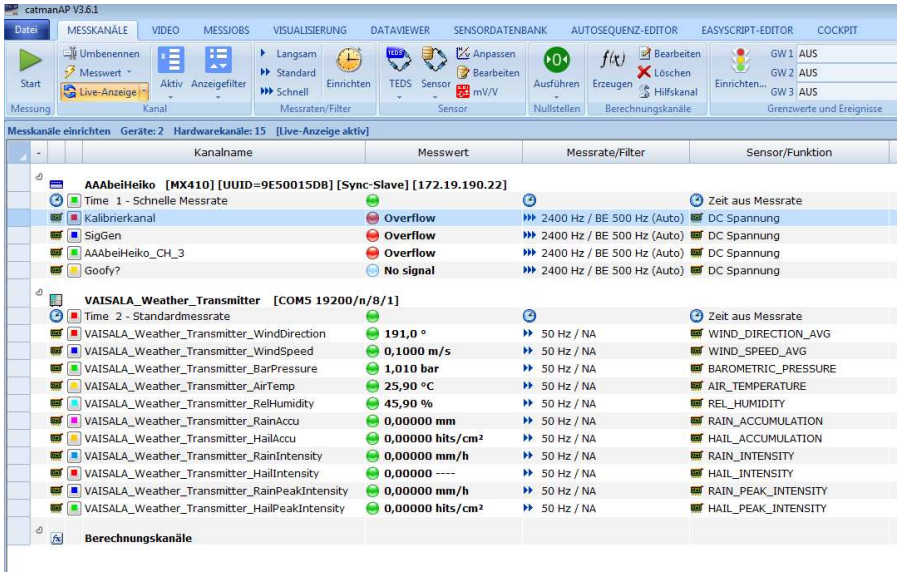
Enhanced workflow for fibre optical interogator

- Assign strain and temperature sensors just by Drag&Drop
  ➔ Physical value will directly be displayed on regular channel;
  No need of extra computation channel
- Fine tune sensor settings via usual Sensor Adaptation dialog
  (e.g. the reference center wavelength for a FS63)
- FS sensors like FS62 (strain), FS63 (temperature) and FS65 (acceleration) from HBM sensor database



Integration weather stations

- Acquire wind speed, barometric pressure, air temperature, humidity, rainfall and hail
- Tested with model Vaisala WXT520



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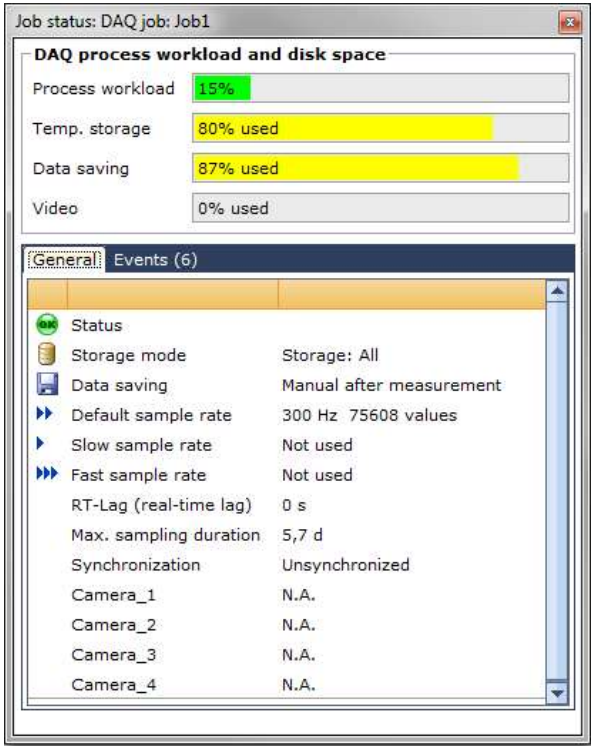
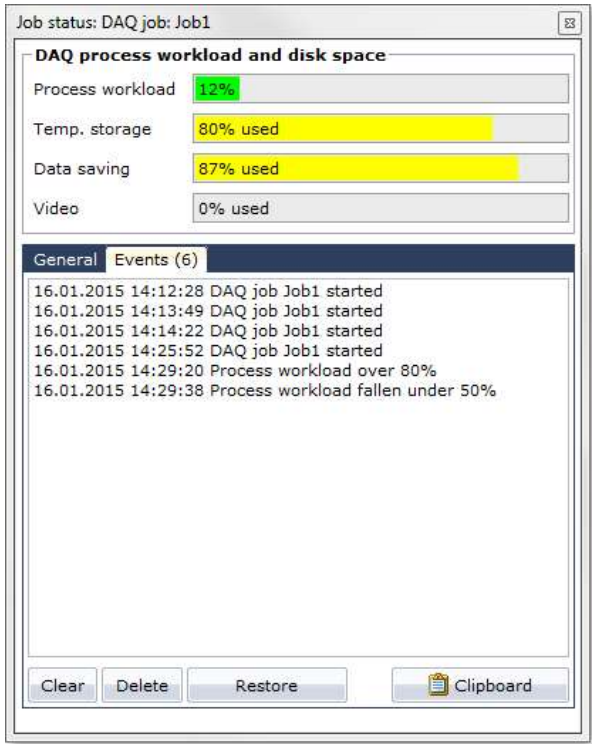
System diagnostic





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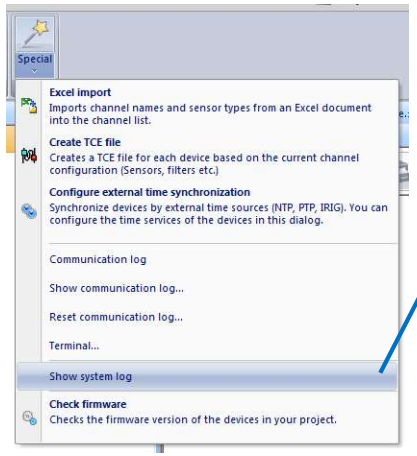
Advanced logging capabilities

- Text format for better readability with 3rd party tools
- If log file exceeds 1MB a new file is created
- **All type of events** are logged
  - DAQ job events (trigger, start/stop DAQ)
  - User events if enabled in options (level crossing)
  - System events
  - Accessible over catman GUI (location in user directory)




```
11.08.2015 14:39:13      0,00 s  DAQ job Job1 started
11.08.2015 14:39:19      6,00 s  Displacement Alert (U9B 200N)
11.08.2015 14:39:20      7,00 s  Start trigger fired
11.08.2015 14:39:27     14,00 s Displacement Alert (U9B 200N)
11.08.2015 14:39:29     16,00 s Displacement Alert (U9B 200N)
11.08.2015 14:39:29     16,00 s Displacement Alert (U9B 200N)
11.08.2015 14:39:38     25,00 s Stop trigger fired
11.08.2015 14:39:38     25,00 s Filling post-trigger
```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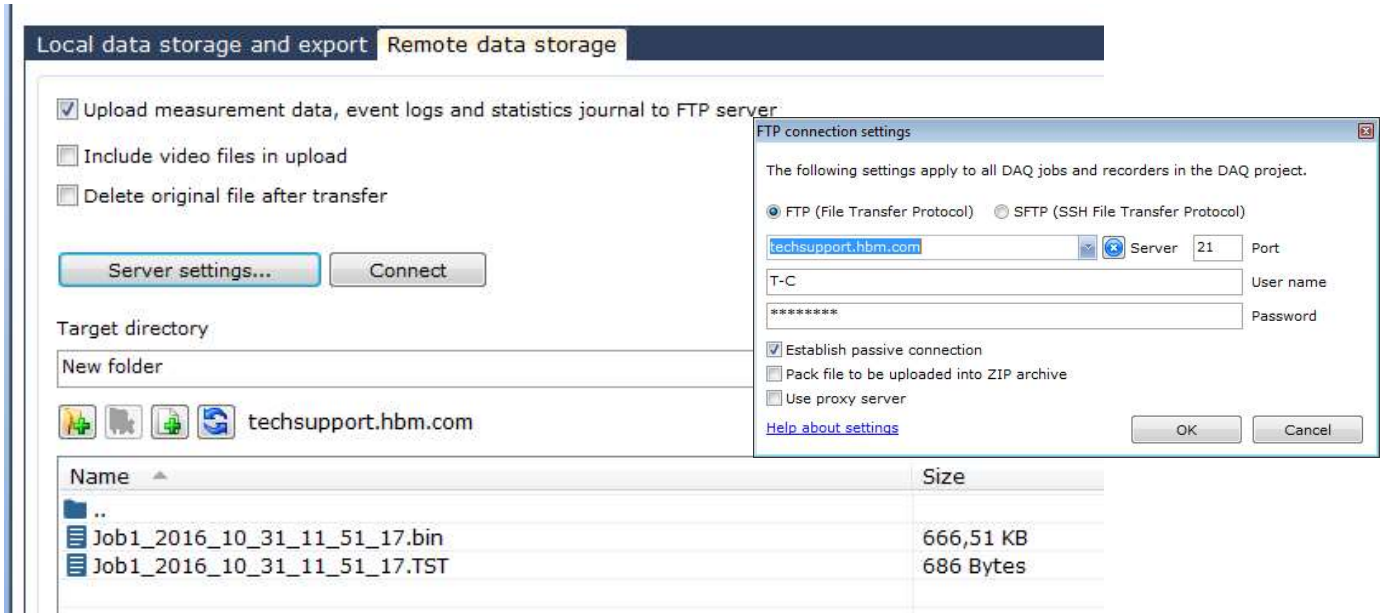
Integrated FTP/SFTP client for data transfer to a server

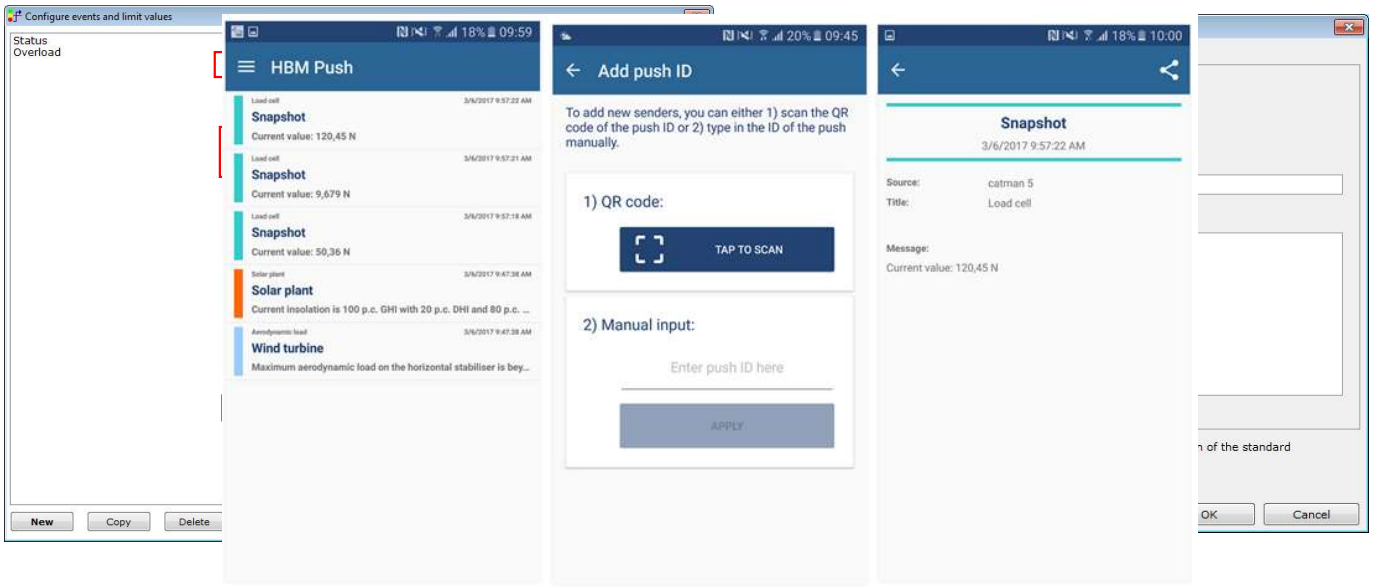
- Client configuration: rules for automatic data transfer; server address; user; password, etc.



Push notifications to smart devices as reaction on a detected event/alarm

- Alarms, e.g. overload
- Warnings, e.g. battery low
- Diagnostics, e.g. system alive

Google Play Store AppleStore



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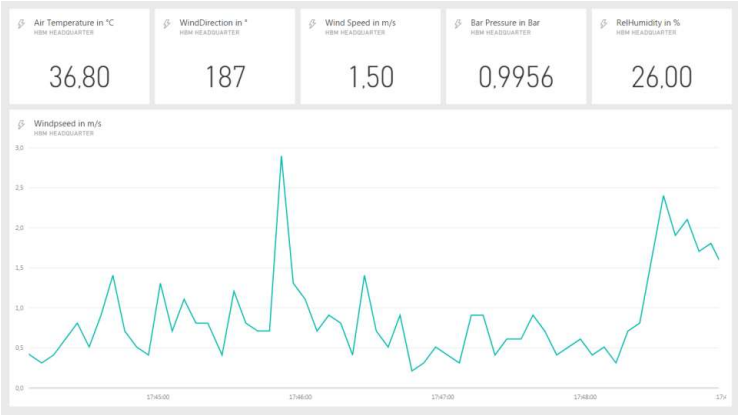
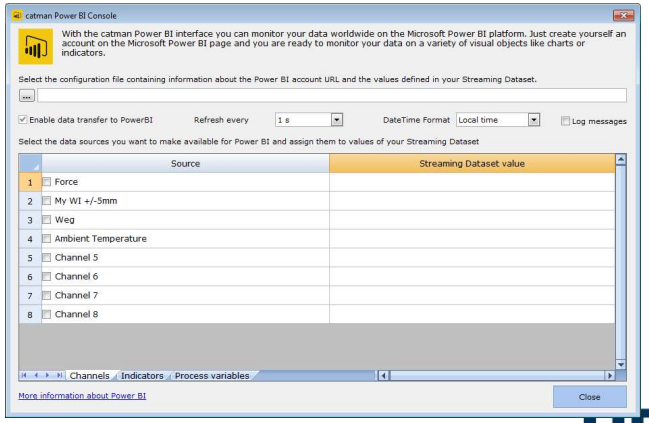
Data streaming to Microsoft Power BI for visualization of data in the web

Live data streaming with a lower sample rate (2 S/s maximum) of selected channels to Power BI dashboards (or generic Endpoint)

- Create Power BI dashboard (visualization) and data endpoints
- Save dashboard and endpoint configuration in text file
- Read text file in catman DAQ project and match catman signals to Power BI variables
- Share dashboard with dedicated users





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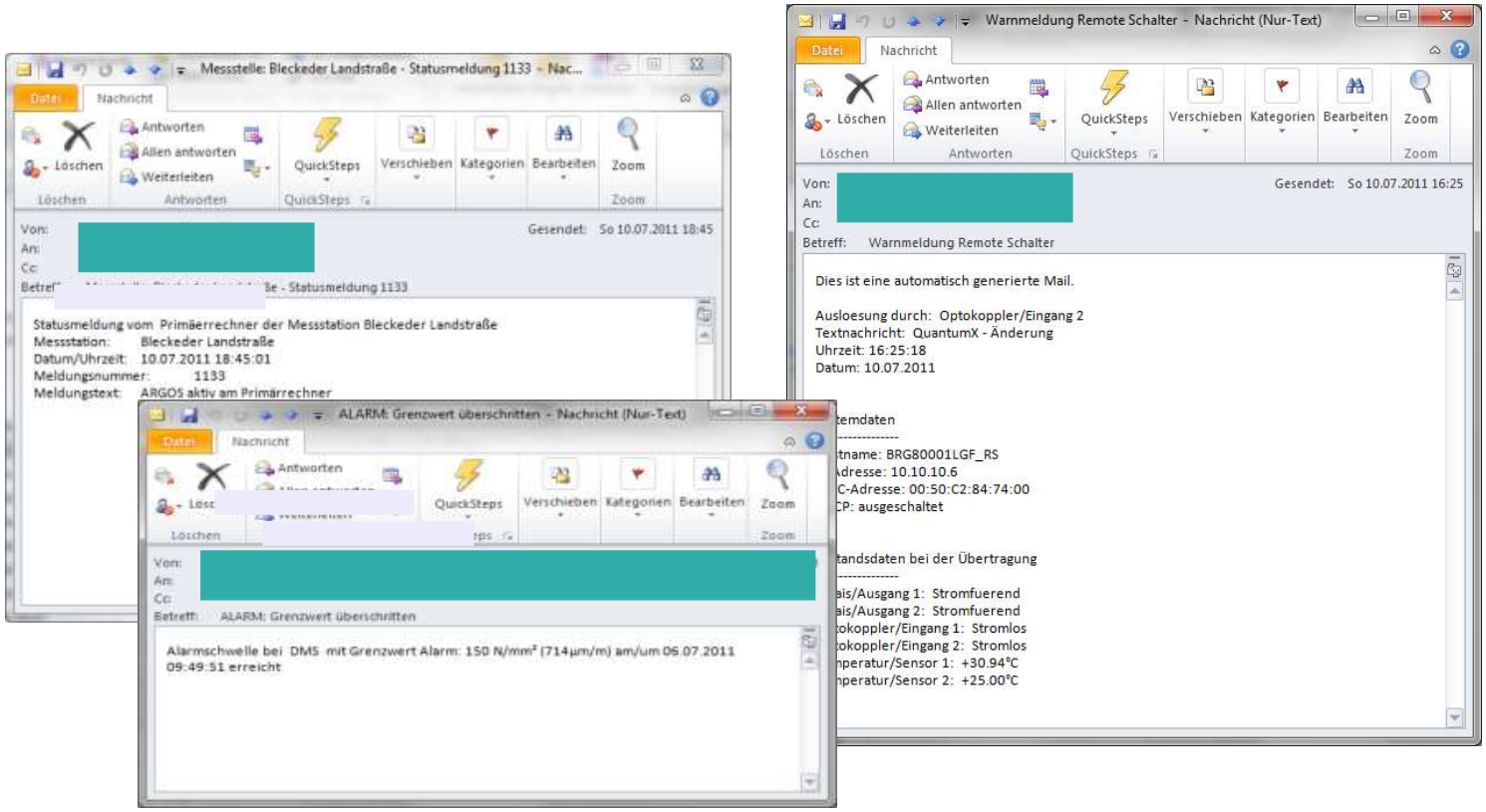
Emails on status change



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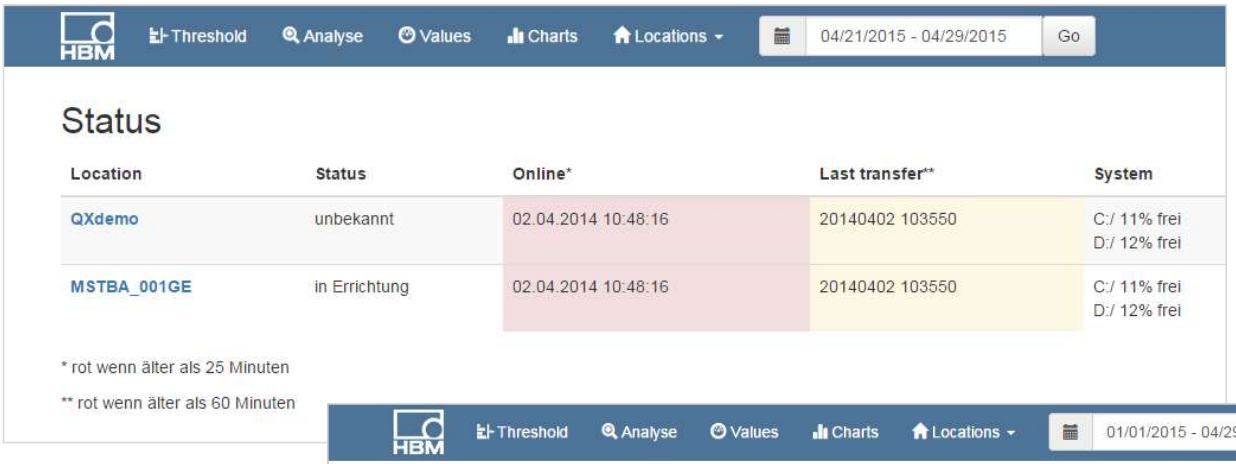
System status (custom solution)



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Overview measured values

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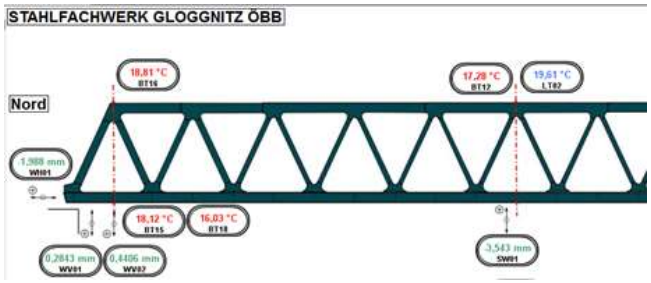
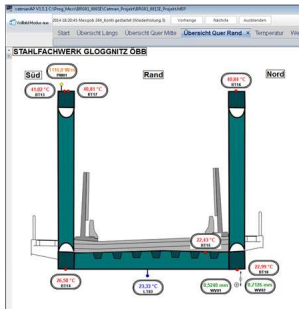
Application example: Railway bridge Austria

- Digital Twin
- Monitoring of temperature influence on the steel construction
- Prove of calculations and assumptions
- 20x Temperature, 6 displacement, 1 pyranometer





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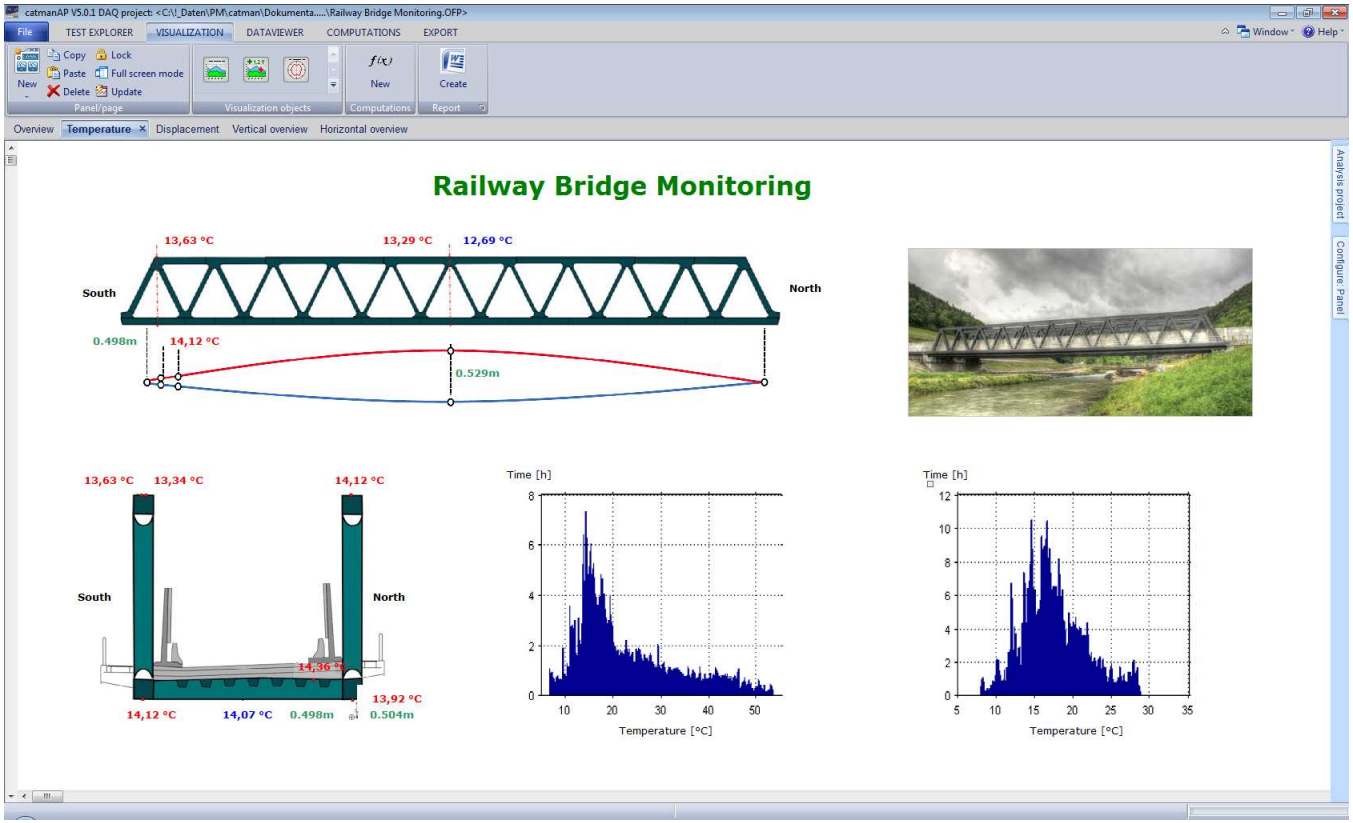

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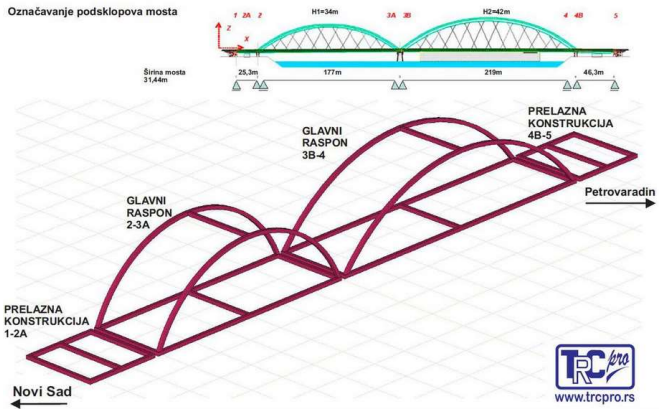
Application example: Zezelj Bridge in Serbia

- Bridge over the Danube River for railway, road traffic and pedestrians
- 2 railway tracks, 2 road traffic lanes, 2 bicycle and pedestrian lanes
- 472 sensors: 328 strain, 80 force, 12 displacement, 32 inclination, temperature
- 24 PMX synchronized over NTP
- Data storage concept: Transfer to data center (FTP) + local storage (USB + internal flash)



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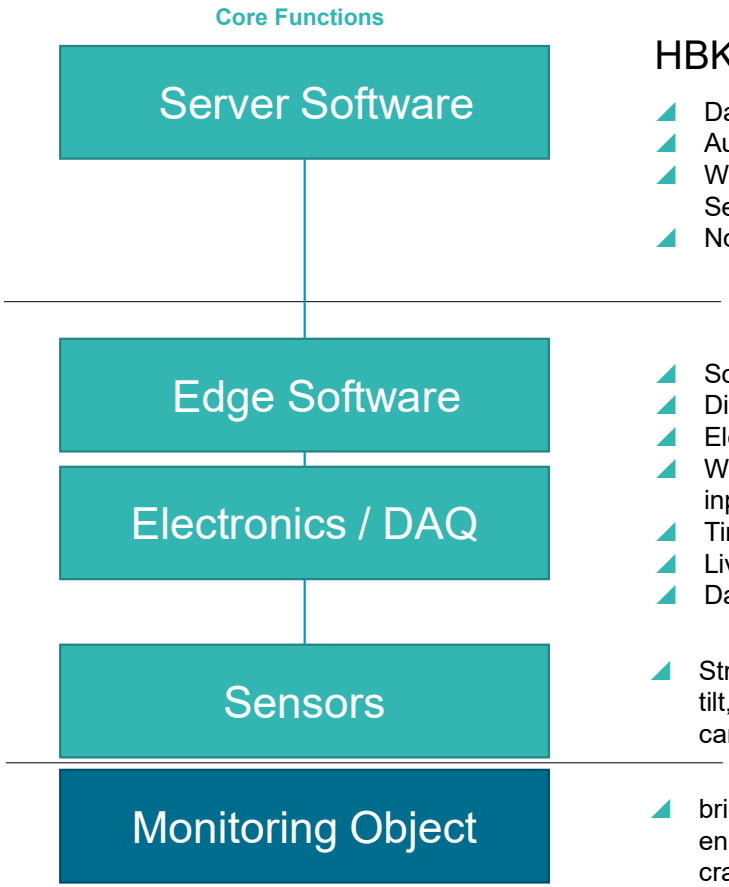
HBM support and scope of supply



HBK Products Offering

- Data visualization and search
- Automated analysis
- Web interface Linux & Windows Server / Cloud
- Notification / Reports

- Scalable inputs
- Distributable / short sensor lines
- Electrical / optical technology
- Wide range of physical and digital inputs
- Time-synchronized data
- Live visualization
- Data preprocessing

- Strain, displacement, acceleration tilt, own and 3rd party sensors + camera, GNSS

- bridge, tunnel, railway, wind energy incl. offshore, oil&gas, cranes, building

HBK Services

- Setup and scale on-premise or cloud
- IT expertise
- Training analysis

- Setup and cabinet mounting
- Turn-key finishing
- Training setup and Edge recording
- Network integration

- Expertise selecting the right sensor
- Field service support (on / offshore)
- Training sensor application

- **Domain expertise**: Civil engineering, railway, wind energy experts incl. offshore, oil&gas

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