The future of Pressure Measurement

The new Cerabar and Deltabar.

Endress+Hauser [EH]

People for Process Automation

The new Cerabar and Deltabar: the future of Pressure Measurement

SIMPLICITY

- Eliminate multiple interface tools or updating DDs/DTMs – Use your smartphone or tablet to commission and communicate
- Guided commissioning – no confusing menu structures
- Transmitter status is visible from 10 meters/30 ft in any light condition
- Simple verification and proof test procedures

Bluetooth

Bluetooth + EH

Industry 4.0/IIoT

SMART SAFETY

- Reduce systematic failures – error free SIL commissioning and Proof Testing
- Reduce on site accidents and protect instruments located in hard to reach areas
- Process monitoring beyond the instrument

Bluetooth

INCREASED PRODUCTIVITY

- Reduce time required to perform instrument proof tests by 50%
- Simplify troubleshooting – cause and remedy are shown on either the display or smartphone
- Improve installation and commissioning efficiency by 30%
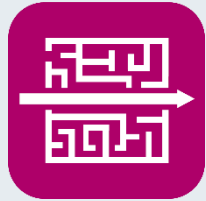- Detect process anomalies; enable predictive maintenance

Heartbeat Technology

Wizards

Endress+Hauser

The new Cerabar and Deltabar: the future of Pressure Measurement

Simplicity

Display operation

Connectivity

HistoROM

Smart Safety

Wizards

Safety by design

Increased productivity

Heartbeat Technology
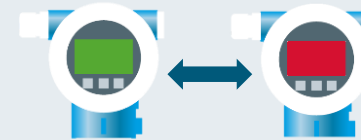
Industry 4.0

Accessories

Endress+Hauser

Display operation

Simply Clever

Increase availability and safety

- Operation via touch control
  → no need to open housing

- Backlight changes from green to **red in case of device failure**

Time savings

- Intuitive commissioning using wizards

Sample use case

- **Problem:** *Hot work permit required to open housing to make adjustments to the transmitter in a hazardous area*

- **Solution:** *Operation via touch control or Bluetooth®*

Simplicity: Segment or graphic display

Segment display with high readability

Graphic display for on site operation

*Backlight and graphic display only available with 7xB series

Endress+Hauser

Simplicity – Touch control for graphic display

Simple

- Proven Endress+Hauser 3-button operation (-/+/E)
- Visual feedback for short or long press activated buttons
- Easy identification of device with failure (Back-light)

Safe

- No need to open housing
- Optical button sensitivity adjusts to light conditions

Simplicity – Display with backlight

Visible on-site device diagnostic

- Backlight changes from green to **red in case of device failure**

- This increases the safety of the plant

- Allows easy and fast identification of a faulty device among multiple instruments

- Clicking on "info" key, actual diagnostic info are showed

- "Home page" and "error description screen" alternate

Endress+Hauser
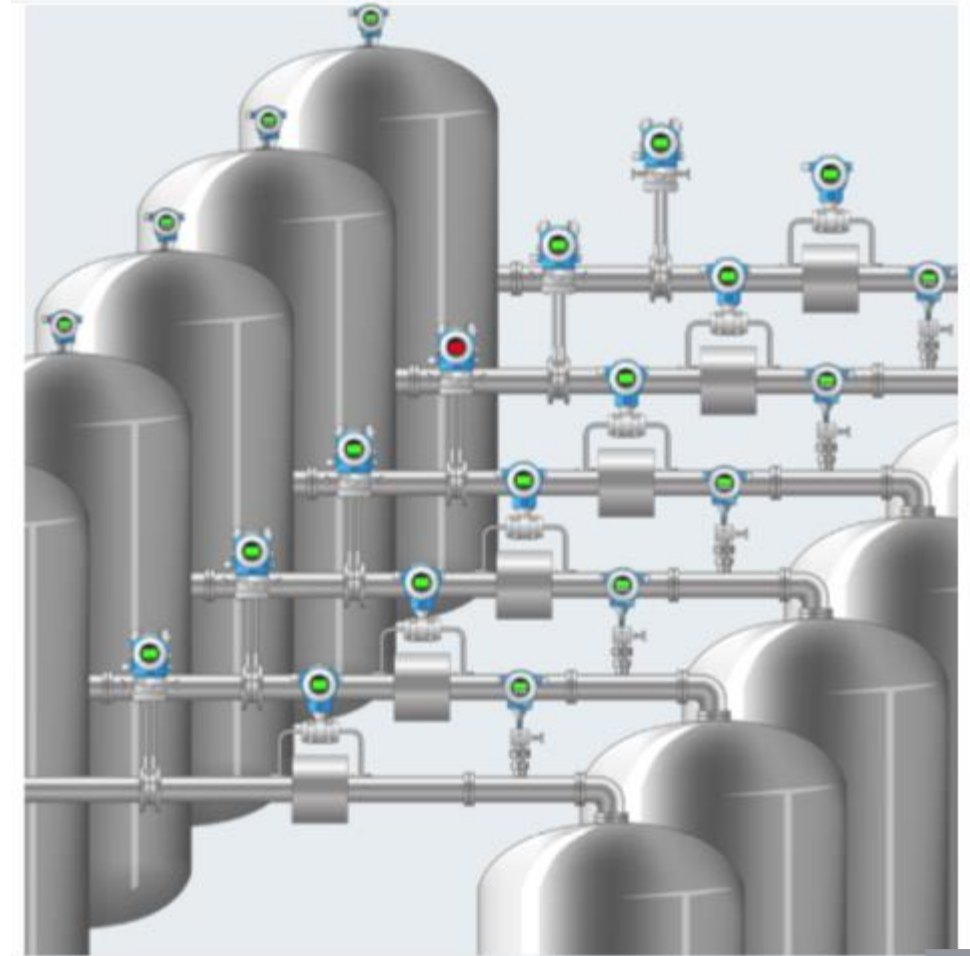
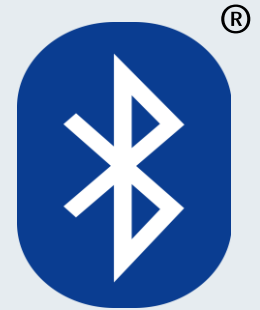# Connectivity via Bluetooth® – the future is now

Secure, safe and simple

Simplicity

- No need to access housing or terminals
- Simple and safe commissioning via wizards

Increased productivity

- Updates via SmartBlue-App
- Simple creation of reports

®

Use case

- *Device needs to be commissioned or verified at a difficult to reach location requiring scaffolding, access to control cabinet, etc ....Maintenance engineer can now commission on site but still remotely*
  - *Estimated cost saving potential: > 50 - 500 €*

Endress+Hauser

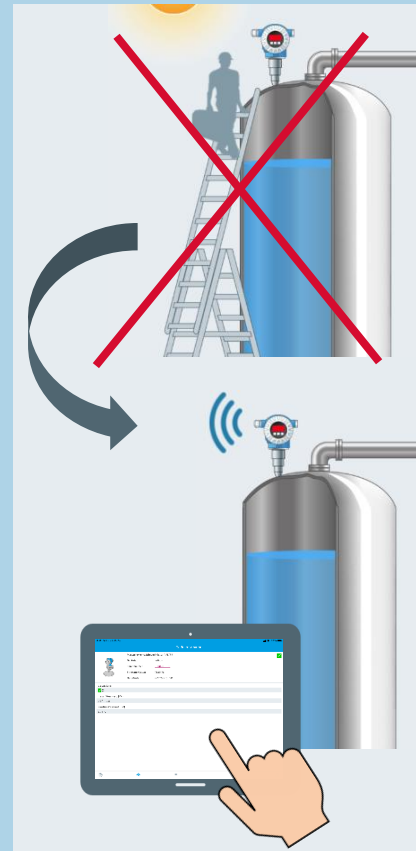# Bluetooth® connectivity for easy, intuitive and remote operation

Easy

No need to search or open loop; Output signal not affected

App-Operation via Tablet/Smartphone is well known and common practice for new employees

Safe

No need to directly access device
- No scaffolding
- No need to access terminals

Worker safety when …
- device difficult to access
- high temperatures
- hazardous areas

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# What is important for devices with wireless data transmission?

- Security against unauthorized access

- Eavesdropping/listening attacks must be unsuccessful even with weak passwords

- Phishing attacks must not reveal exploitable information

- Data found in a stolen or lost smartphone must not reveal any information about access to the measuring device

- Data found in a stolen measuring device not reveal any information about access to it

- An attack by downloading manipulated device firmware must be impossible

Cerabar/Deltabar provides high security against all these topics

Endress+Hauser

Endress+Hauser Bluetooth® concept

- All Endress+Hauser Bluetooth® devices can be accessed with just 1 app (SmartBlue-App)

- The app works with all current and future Bluetooth® devices

- There is no limitation of numbers of connected devices

- Endress+Hauser uses the PAKE principal which is also used in the German identity cards

- The security level is independent of the password quality

- The password is never stored on neither side (app or device)

- **Security specialists from Fraunhofer Institute for Applied and Integrated Safety (AISEC) have stated that our security level is high (whereas standard Bluetooth encryption is "low"!)**

®
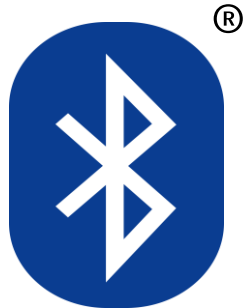
As a summary we derive the following final verdict about the information security protection level of the Bluetooth-based infrastructure after the analysis, based on the attacker model and derived project-specific protective goals[23]:

Protocoll	High
Algorithms	High

Fraunhofer AISEC

Security level scale by Fraunhofer AISEC	Time an attacker needs to hack a device
Low	Hours to days
Medium	Days to weeks
High	Weeks to Months
Very high	Months to years

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Endress+Hauser Bluetooth® security in the field

Role	Task	System requirements
Plant operator	View device status and measurement values	- Mobile Tablet with SmartBlue-App - In live list: view all devices in range - TAG and icon with PV, SV and status if previously connected to device with specific mobile tablet - TAG only if no previous connection between device and specific mobile tablet
Maintenance Engineer	Commission and/or change configuration	- Mobile Tablet with SmartBlue-App Bluetooth password for device (default and can be changed) - Optional: User role can be set to „Operator" at end of task which would require an additional user role password to change configuration

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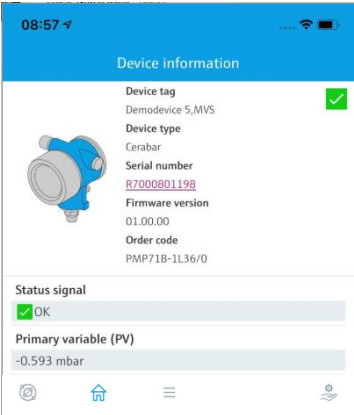
HistoROM® for easy data management

## HistoROM® for data management without additional tooling

- Backup and restore functionality/parameter settings

- Data Unit is exchangeable in case of a replacement of the main electronics

- Replacement even at night shift or weekend

- After the exchange, no calibration necessary

Use case

- *Electronic fails in night shift and no replacement device is available.*

- *Solution: Use electronic as spare part from stock or from another device, remove defective electronic, plug HistoROM from old to new electronic, insert new electronic into device. Done.*

- *Time required on site: < **10 min***

Endress+Hauser
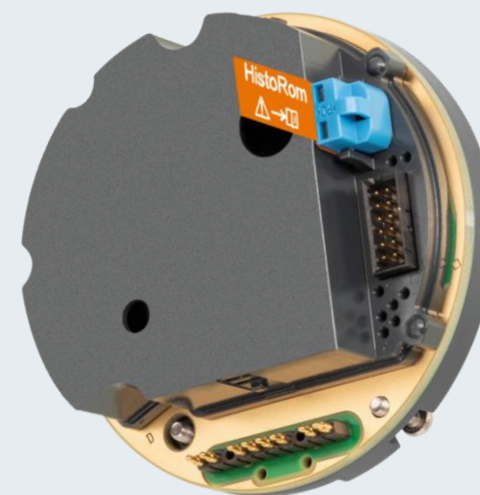
Guided intuitive setup sequences – Wizards
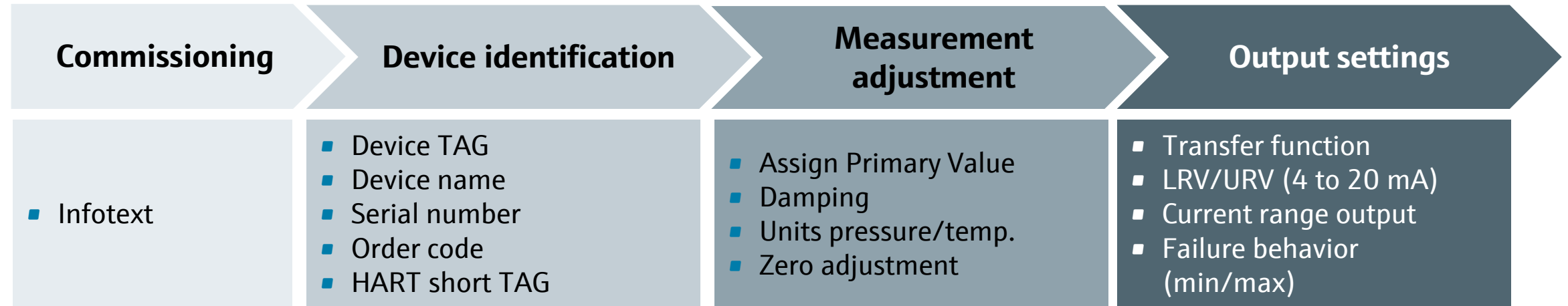
Instrument led sequences for …

- Commissioning
- SIL-locking
- SIL proof test
- Heartbeat Verification
- Heartbeat Monitoring

Use case

- *The guided wizard reduces „menu-hopping" and can* **reduce the time for commissioning by 30%.** *Additional systematic errors are reduced (e.g. forgotten parameter setting).*

- *Time savings with Wizards via Bluetooth®:* **> 8 minutes**

Example – Commissioning a pressure device in 4 Steps

Commissioning	Device identification	Measurement adjustment	Output settings
- Infotext	- Device TAG - Device name - Serial number - Order code - HART short TAG	- Assign Primary Value - Damping - Units pressure/temp. - Zero adjustment	- Transfer function - LRV/URV (4 to 20 mA) - Current range output - Failure behavior (min/max)

Minimizes errors

- Guided sequence through all relevant parameter settings

Saves time

- No need to jump between different menus
- On site yet remote commissioning via Bluetooth® possible

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Wizard overview

> **i** All wizards can be found under „Guidance"

Wizard		DTM FieldCare	EDD	Bluetooth® SmartBlue-App	Graphic Display
Commissioning		✔	✔	✔	✔
Heartbeat Technology	Heartbeat Verification	✔	✔	✔	✔
	Statistical Sensor Diagn.	✔	✔	✔	�’️✘
	Loop Diagnostics	✔	✔	✔	✘ *
	Process window	✔	✔	✔	✘ *
SIL	SIL-mode (locking)	✔	✔	✔	✔
	SIL-proof test**	✔	✘	✔	✘
Reports (PDF)		✔	✘	✔	✘

* function available but not as wizard, only via Diagnostic menu   ** Proof test wizard only available when SIL and Heartbeat Option are selected

Integrated Report-Function (PDF) at the end of wizards

Wizard		Report (PDF)
Configuration Report (PDF)		✔
Commissioning		*
Heartbeat Technology	Heartbeat Verification	✔
	Statistical Sensor Diagnostics (SSD)	*
	Loop Diagnostics	*
	Process window	*
SIL	SIL-Mode	✔
	SIL-Proof Test	✔

* all Parameters and/or results are included in configuration and/or Heartbeat Verification report

Simple
- Standardized documentation at end of wizard

Compliance
- Document settings/ procedures/results

Smart Safety – for safe and reliable measurement

Safety by design

- Diagnostic coverage > 95% which includes undervoltage detection and specific systematic faults
- Development according to IEC 61508

Safe operation

- Remote SIL Locking and partial proof testing possible
- SIL Wizards and CRC ensures safe operation
- Backlight display: clear identification of device in alarm

Use Case

- *In safety applications, it is all about risk reduction. Using the SIL mode wizard for locking and the CRC, systematic errors can be reduced to a minimum. The wizards ensure that the procedure is independent of the person performing the maintenance task*

Smart Safety by design

Developed to IEC61508

Highest Diagnostic coverage
DC > 95%; e.g. Under voltage detection

Bluetooth®
- Safe remote access
- Certified encrypted data transmission

Secondary Containment
Secondary process barrier with gas tight feed-through to housing

Sensor-/Membrane technology
- Fit-for purpose sensors
- Different technologies for maximal availability (e.g. ceramic, TempC, High-pressure, etc...)
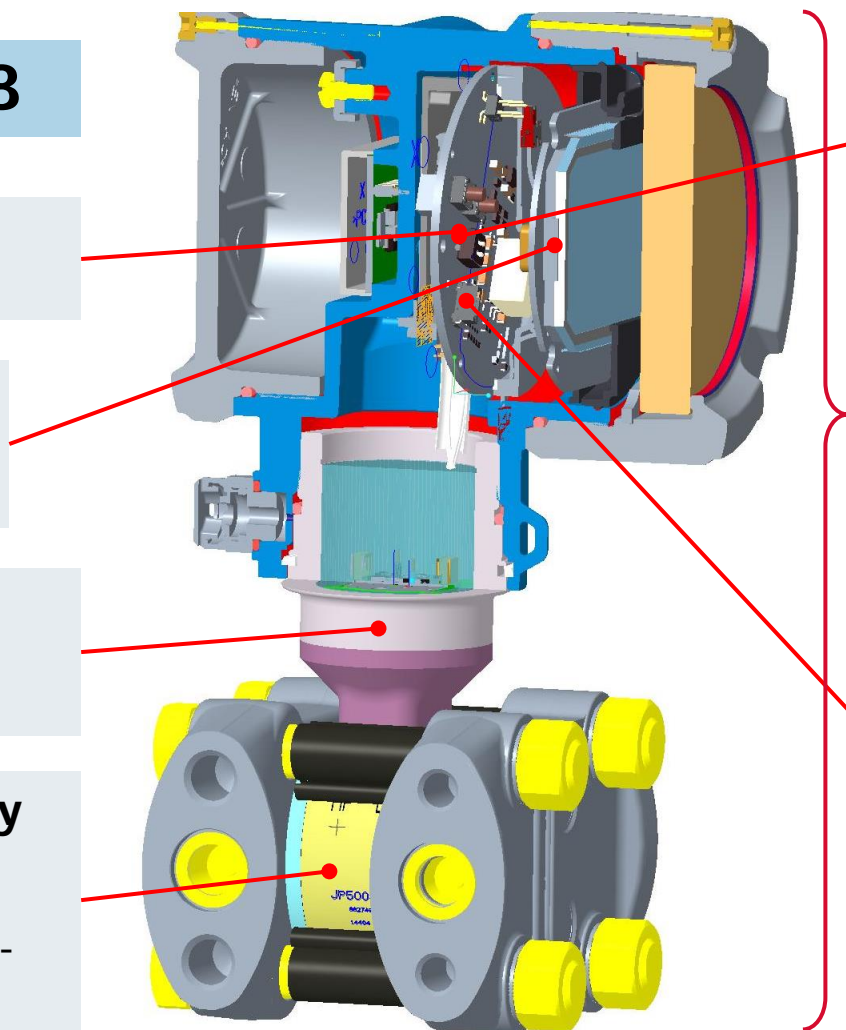
Wizards
- Guided SIL-mode, proof testing wizards
- Heartbeat Verification
- Heartbeat Monitoring configuration

Heartbeat Technology
Highest diagnostic coverage plus additional diagnostic events based on Heartbeat Monitoring data (systematic faults)
In-situ Verification of device function
Additional monitoring data

CRC & Configuration counter
Tracking of configuration changes and changes in safety relevant parameters settings with Checksum helps minimize systematic errors during maintenance

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CRC (Cyclic Redundancy Check)

The problem

For a differential pressure transmitter, there are **10 different safety relevant parameters** that influence the device behavior/current output

(e.g. damping, failure current, square-root, LRV, URV, …)

- What are these parameters and how can I easily validate that these parameters where not changed after a maintenance event

The solution

Unique CRC-Checksum (CRC device configuration) based on the safety parameter settings. The CRC is updated with each parameter change and can be used to document required settings to …

- Avoid human error after maintenance

- Document the settings of the device with one CRC

- Validating correct device settings

Has any parameter that will influence output behavior been changed?

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Stored CRC in SIL Locking wizard

https://youtu.be/wwZ39I6u1YA

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Track changing parameter settings

Function

- CRC is always updated
- At end of SIL wizard, the current CRC is stored
- At end of SIL wizard, the device is locked

If, e.g. after a maintenance event, a device is unlocked, a comparison of actual CRC to stored CRC can be done.

Compare CRCs to determine if a safety relevant parameter have been changed : **Stored CRC ≠ actual CRC: safety relevant parameter has been changed**

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Increased productivity – Heartbeat Technology

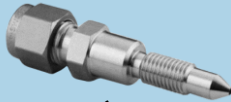## Heartbeat Technology – Device verification and process monitoring

- Verification without process interruption to increase reliability in production and optimize proof tests intervals (systematic faults)

- Monitoring functions that enable predictive maintenance
  - Detect process anomalies, e.g. plugged impulse lines or closed valves
  - Detect faulty supply voltage or corroded terminals
  - Detect and quantify dynamic pressure/temperature peaks

Use cases

- *In-situ verification via Bluetooth in < 3 minutes even for devices connected to analog IO card*

- *A continuous monitoring of the terminal voltage/current detects possible leakage currents due to water in housing, wiring issues or corroded terminals in junction box which may lead to a critical device failure. Helps avoid plant shutdowns*

Endress+Hauser

Heartbeat Verification – also for 4-20 mA devices

Method	Offerings by Endress+Hauser
Heartbeat Verification	**Heartbeat Verification** • Device verification in < 3 minutes • Includes information of systematic faults
Calibration	**Accessories + Service** • Endress+Hauser-Calibration Service • Accessories mounted or enclosed (e.g. calibration fitting)
Proof testing	**Wizard for SIL-proof testing** • Guided proof test procedures as described in safety manual with defined PTCs • PDF-Documentation → Compliance

Endress+Hauser

Heartbeat Verification – also for 4 to 20 mA devices

https://www.youtube.com/watch?v=rl-6iUZ0HPQ

Endress+Hauser
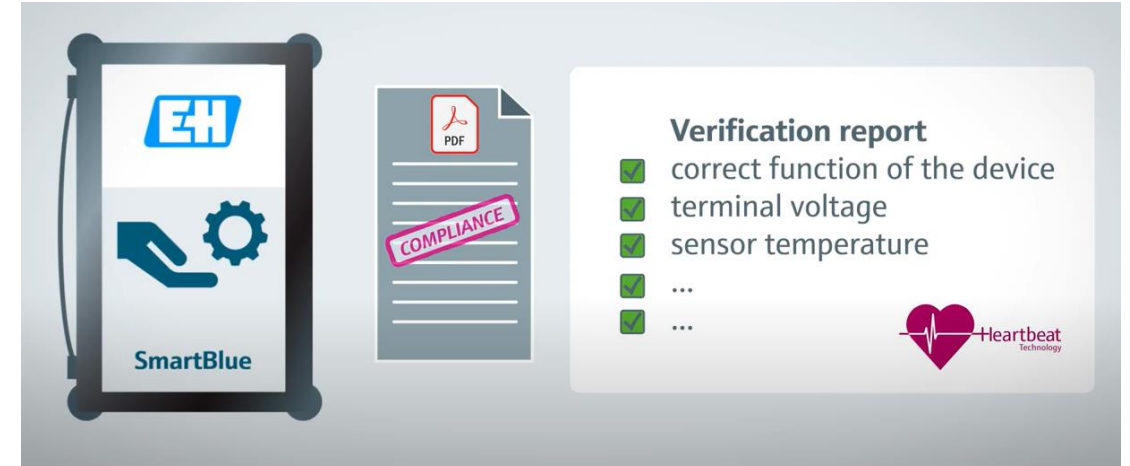
Heartbeat Monitoring: Statistical Sensor Diagnostics

Statistical Sensor Diagnostic to detect plugged impulse lines for example ANY process anomaly that results in a change in the signal noise of the pressure signal.

Using statistical data or pressure signal (median and noise) to detect possible anomalies

1. After maintenance, it was forgotten to open valve

2. Plugged impulse lines Deltabar and Cerabar (small URV only)

3. Flooding of Distillation Column Packing (Deltabar)

4. Air in water
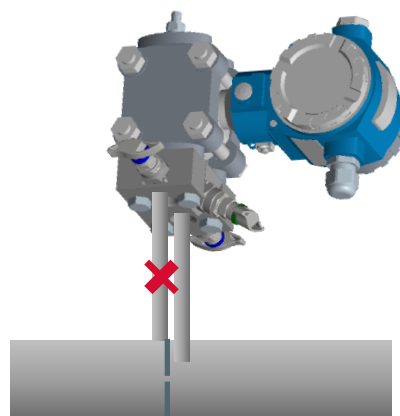
5. Agitator defect

Endress+Hauser

Heartbeat Monitoring: Statistical Sensor Diagnostics

Gains and KPIs:

- Higher process reliability by detecting process anomalies such as plugged impulse lines or valve that was accidently left closed after maintenance event


Basics and preconditions:

- Applicable for all Deltabar 7xB and Cerabar PMx71B with small measuring ranges. Signal : signal noise < 100:1
- Stable process conditions, enough signal noise and good signal/signal noise relation

How it works:

- Define process conditions when monitoring function should be active by creating a pressure baseline
- Define threshold signal noise under these conditions
- Monitor signal noise. Signal noise will go up/or down depending on which impulse pipe is plugged
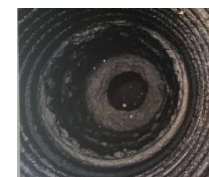
Build-up on orifice plate in coke gas application

Note:

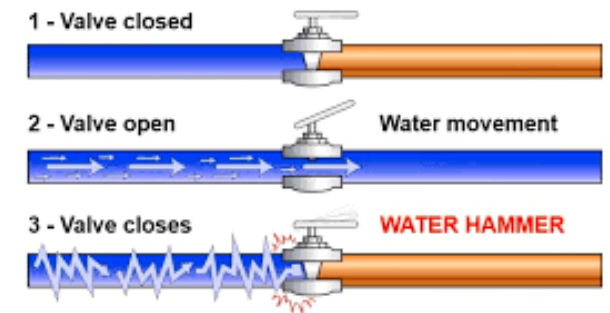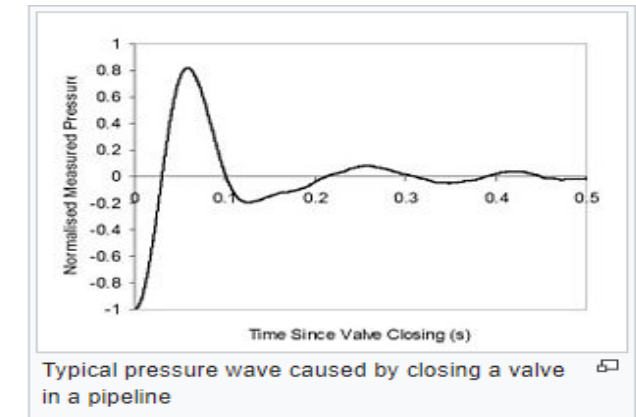- Predominant use case is with differential pressure applications
- In pressure applications, the change in signal noise due to a build-up on the membrane usually is not significant enough in relation to the pressure to make a reliable detection
- Ideally, the unwanted state should be simulated (close valve to simulate a plugged impulse pipe) to optimise the parameter settings and allow a reliable detection

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Heartbeat Monitoring: Process Window Pressure

Process Window to detect and quantify mechanical stress for example

- Detect pressure peaks that go unnoticed in 4 to 20 mA output

- Dynamic peaks < 10 ms can be detected (signal analyzed before damping and signal processing)

- Unwanted causes of dynamic pressure peaks

    - Water hammer (valve)/steam hammer

    - Pulsating flows

    - Etc. …

- What to do with this information?

    - Use data to quantify mechanical stress as predictive maintenance information for linked assets (e.g. valves, pumps, welding seams, …)

Typical pressure wave caused by closing a valve in a pipeline

1 - Valve closed

2 - Valve open — Water movement

3 - Valve closes — WATER HAMMER

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Heartbeat Monitoring: Process Window Temperature

Gains and KPIs:

- Increase reliability by detecting frozen pipes, defective heat tracing or enclosure heaters
- Quantify thermal stress in a piping system & correlate maintenance activities (e.g. replace gaskets)
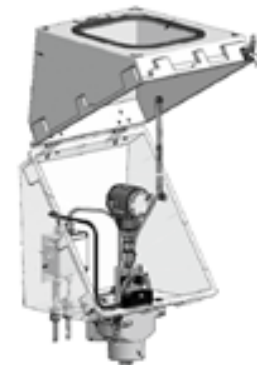
Basics and preconditions:

- Monitoring parameter: min/max temperature and counter with user defined limits

How it works:

- User defined min/max temperature peak counter increases every time the threshold is passed
- Data available via HART as NE107 message, as acyclic information and in Heartbeat Verification Report

Monitor heating jacket

Monitor enclosure heater

Note:

- The peak counters are incremented by one every time the threshold is passed. Threshold should be defined as a fixed value above the normal operating conditions

- Thermal stress usually does not affect pressure device. This data can, however, be valuable for predictive maintenance modelling for other assets such gaskets, welding seams, etc.

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Heartbeat Monitoring: Loop diagnostics

Gains and KPIs:

- Use loop diagnostics to detect wiring issues before critical faults arise

Increased loop resistance or faulty wiring, e.g. due to leakage currents
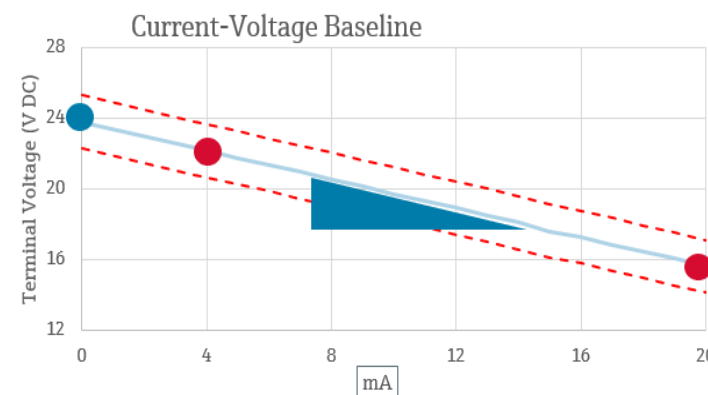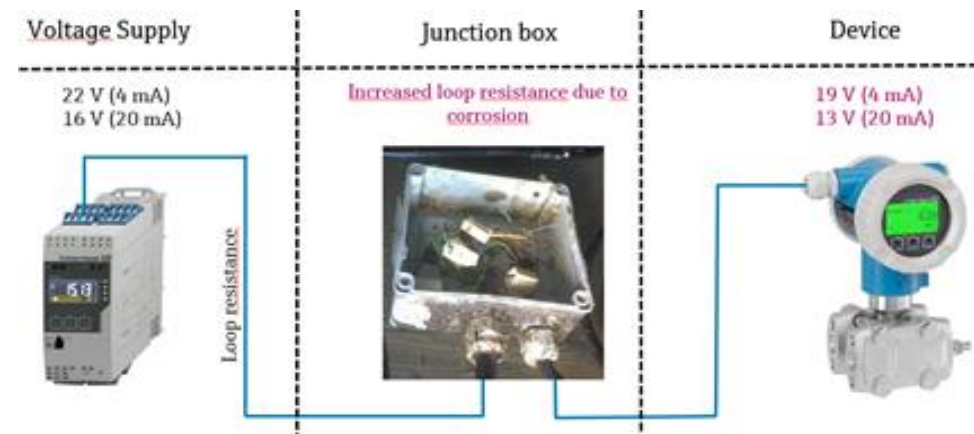
Basics and preconditions:

- Applicable for all Cerabar/Deltabar 7xB
- Monitoring parameters: terminal voltage, terminal current, baseline with loop resistance and supply voltage

How it works:

- During commissioning, the current/voltage baseline (—) is recorded by simulating current outputs (•) to determine the loop resistance (slope of baseline) and the supply voltage (•)
- Set thresholds and output behavior around this baseline
- An event is generated as soon as the terminal current/terminal voltage falls below threshold (---)

Note:

Little effort: only 3 minutes extra commissioning time to record baseline and activate

# Connecting to the future

Industry 4.0 = Data + Connectivity

The foundation is given

- Smart Sensors provide additional relevant data (Heartbeat Monitoring) for big data analytics for use in process optimization /predictive maintenance algorithms

- Connectivity of data via Bluetooth® or WirelessHART

- Industry 4.0 implementation with Netilion from Endress+Hauser

Use Case

- *Problem: 70% of pressure devices are connected to analog IO Cards; additional relevant information cannot be accessed*

- **Solution:** *Use FieldPort SWA50 to relay additional data via Bluetooth® or WirelessHART to DCS or Cloud applications*

Endress+Hauser

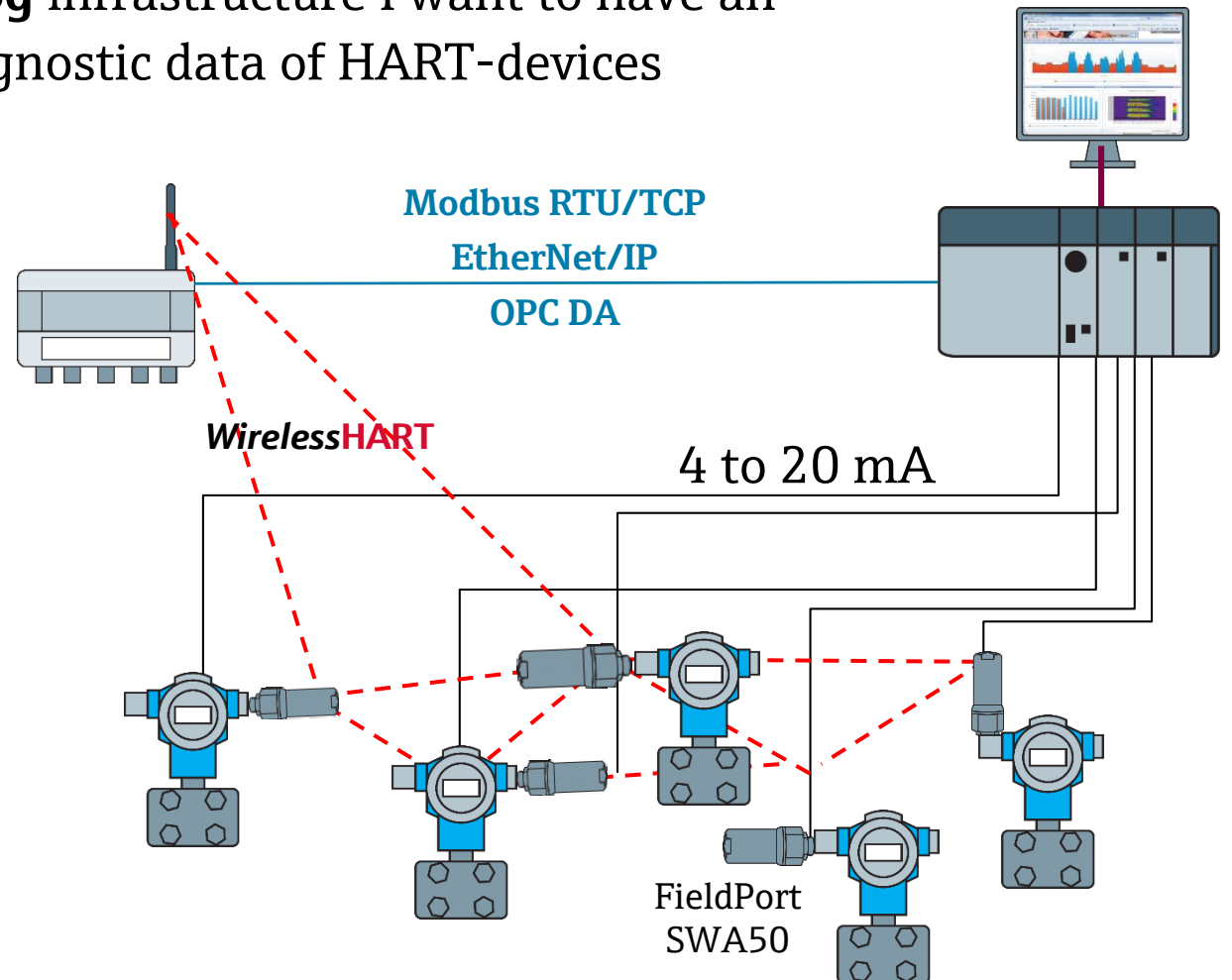# Data and Connectivity via second channel

Endress+Hauser
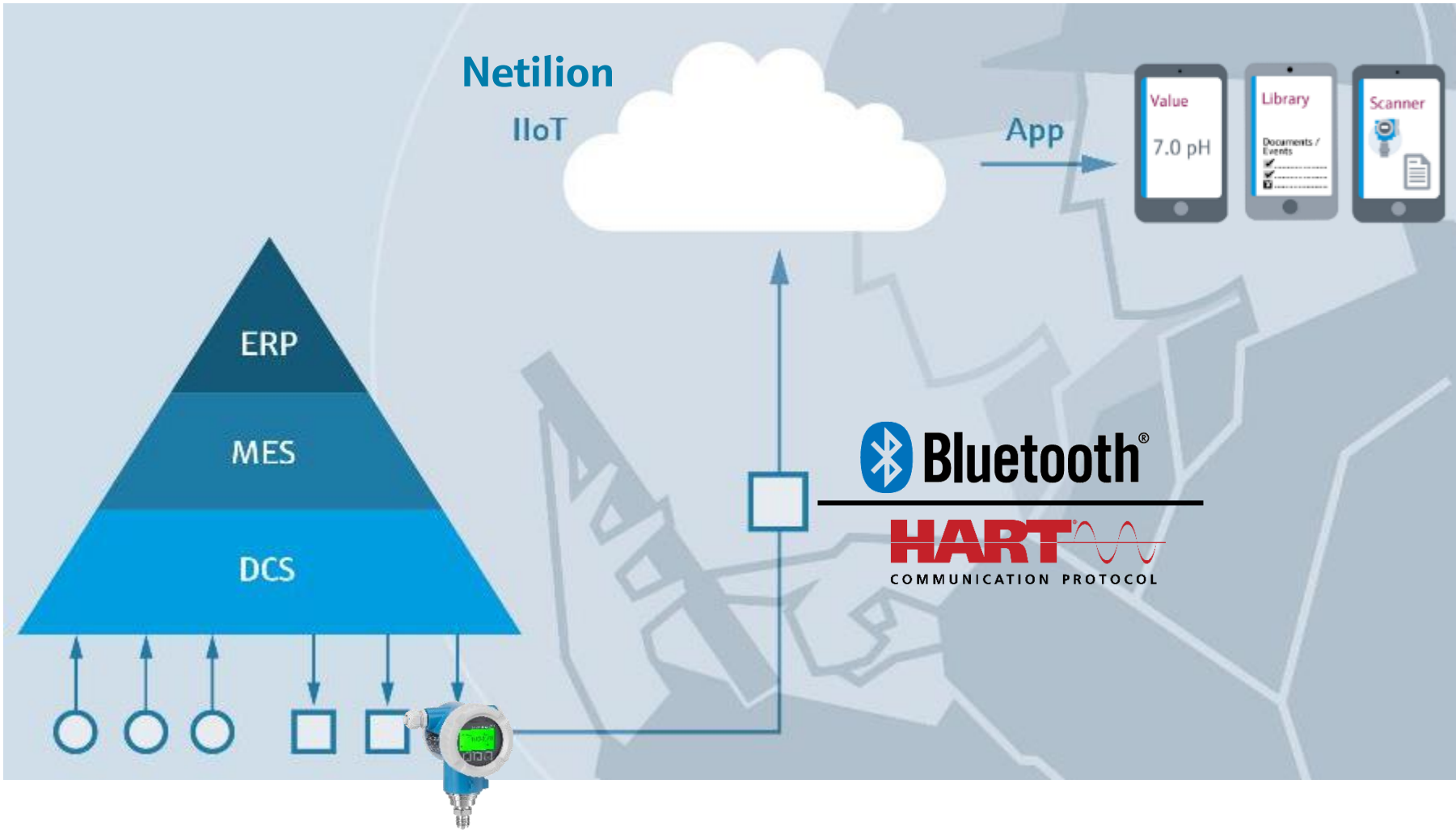
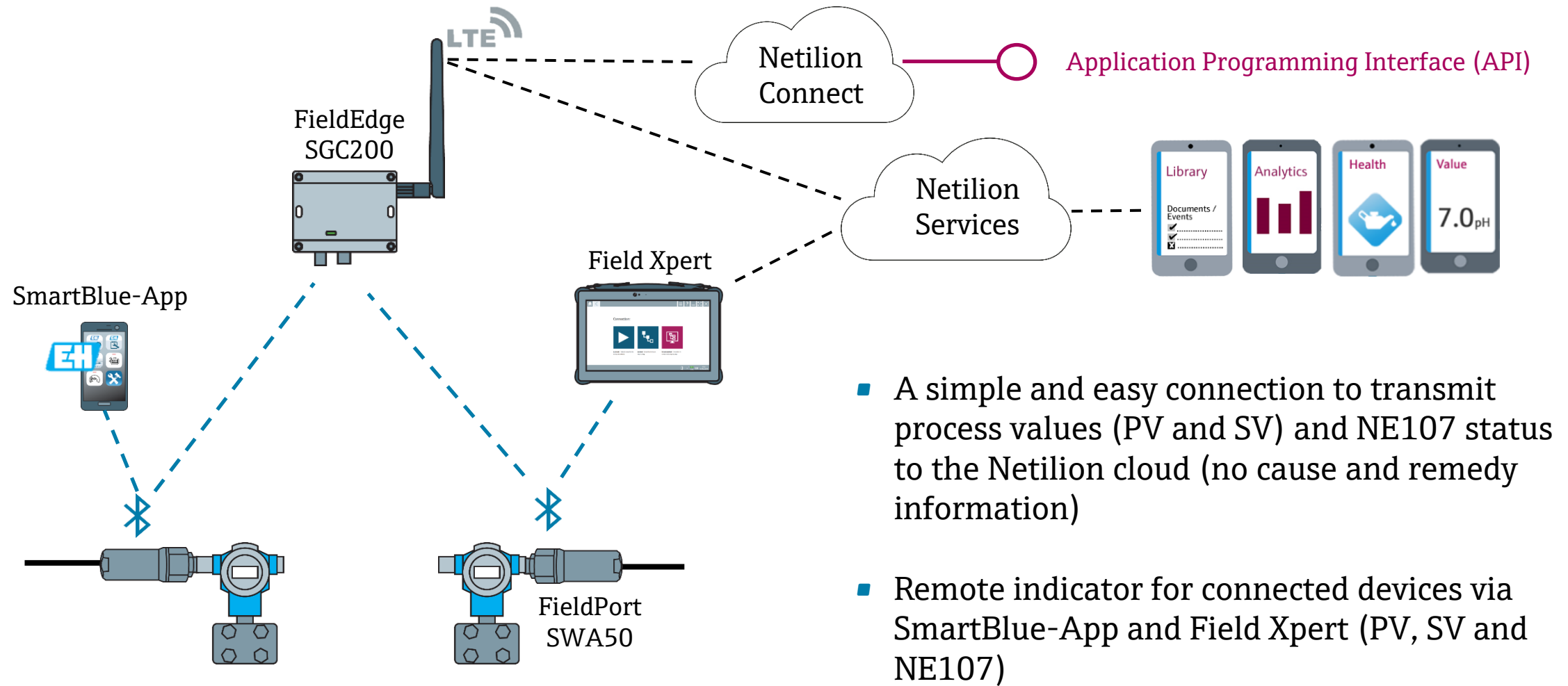# Retrofitting customer plant and accessing Heartbeat Monitoring data

As end customer of existing plant with **analog** infrastructure I want to have an access to Heartbeat Monitoring data and diagnostic data of HART-devices

Customer benefits

- Cost savings for additional process sensors using full functionality of existing HART device

- Cost savings making predictive technical services with diagnostic data and Heartbeat Monitoring data of HART device

- Cost saving for connectivity

Modbus RTU/TCP
EtherNet/IP
OPC DA

*Wireless*HART

4 to 20 mA

FieldPort
SWA50

Endress+Hauser

Accessing more relevant data via 2nd Channel and Bluetooth®

- A simple and easy connection to transmit process values (PV and SV) and NE107 status to the Netilion cloud (no cause and remedy information)

- Remote indicator for connected devices via SmartBlue-App and Field Xpert (PV, SV and NE107)

Endress+Hauser

Heartbeat Monitoring data: relevant data for sample use cases

Monitoring value	Sample use case	Relevant data from device
Build-up *	• Plugged impulse lines/closed valves • Flooded distillation columns	• Pressure signal median value • Pressure signal noise value
Inhomogeneous medium *	• Air entrainment in fluids • Flame stability	
Mechanical stress **Pulsating flow**	• Water/Steam hammer • Faulty dampener • Predictive maintenance for other assets	• Pressure min/max • Counter over/under pressure
Thermal stress	• Aging of gaskets • Predictive maintenance for other assets	• Temperature min/max • Counter over/under temperature
Connection and power supply	• Faulty wiring, corroded junction box terminals • Deteriorating power supply	• Terminal current/Terminal voltage • Baseline Loop resistance

*: depending on application conditions, mainly Deltabar

Increased productivity: Large range of integrated offering

Procurement
One stop shop for transmitter, manifolds & accessories

- No additional lead time for mounting
- All documents available via Serial number online in CER
- One carton for all measuring point relevant components

Installation
Less installation effort/no missing parts on site

- For manifolds: Documented leakage tested assembly (no need to check if PTFE gasket is in place)

Engineering
Always fits

- Exclusions ensure mechanical compatibility (e.g. FNPT or MNPT?)

Endress+Hauser