Enable condition monitoring & predictive maintenance for HVAC systems with Infineon

Infineon's virtual show 2020

Agenda

1. Introduction to Condition monitoring & Predictive maintenance
2. Partnership with Klika Tech & AWS
3. Infineon offering
4. Summary

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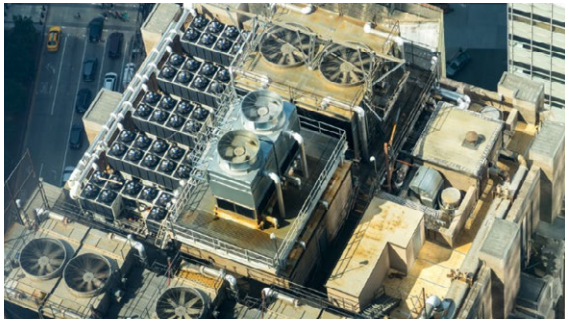
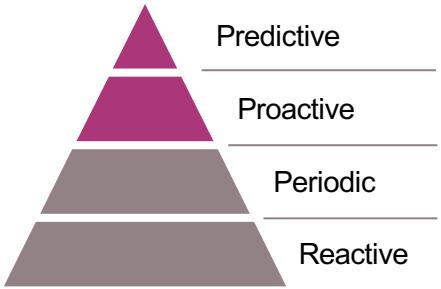
Predictive maintenance can help overcome today's challenges in maintenance of HVAC systems



- HVAC (heating, ventilation, air conditioning) systems **crucial part** of a buildings infrastructure – especially in critical settings such as hospitals, airports, data centers
- Most **critical elements** causing breakdown in HVAC equipment in case of failure:
  - Compressor
  - Motor
  - Piping

Predictive maintenance reduces overall downtime and increase operational efficiency



Identify and avoid underlying root-causes for failures and maintenance by performing corrective activities.	Proactive	Predict equipment failure based on the current equipment condition and take actions.	Predictive
Repair devices and provide maintenance in case of device failure.	Reactive	Provide maintenance on equipment based on a fixed time interval.	Periodic

Infineon and its partner help solve design challenges in adding IoT sensors in HVAC systems

Desire	Add new & innovative use cases to HVAC systems	Integrate smart HVAC equipment into system	Collect and make use of data	Send data to cloud for information processing
Challenge	Limited knowledge in sensor and other IoT technology	Concerns about data security	Transform sensor data into actionable information	Lack of expertise in cloud connectivity

To solve these challenges for customers, Infineon partnered up with experts in IoT & cloud services

Infineon	Klika Tech	AWS
› Expert in sensors, embedded security and power semiconductors › Strong footprint in powering HVAC systems	› Expert in design of IoT solutions › Development of sensor data anomaly score	› Expert in cloud solutions for data processing › Analytic tools

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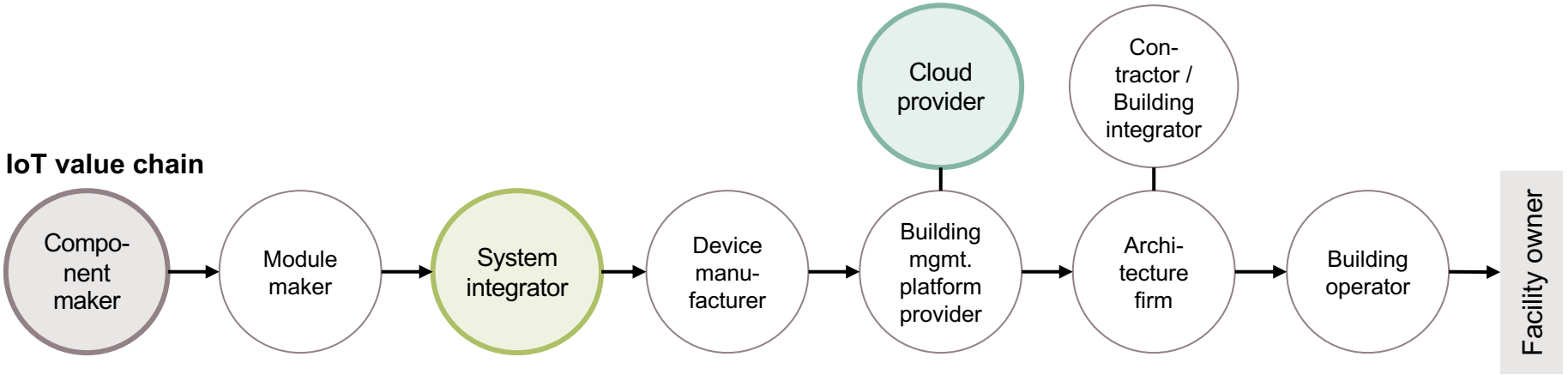
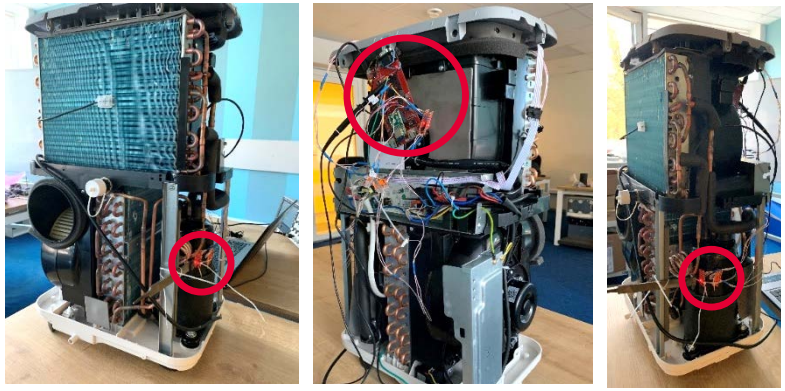
Together, Infineon, Klika Tech and AWS offer a compelling end-to-end solution product offering along the IoT value chain



Infineon	Klika Tech	AWS
› Sensor and power hardware expertise › Strong footprint in powering HVAC systems	› System integration › Software for condition monitoring and predictive maintenance	› Cloud for data processing and analytics › Analytic tools

System-level demonstrator for predictive maintenance showcases potential of sensors in HVAC systems

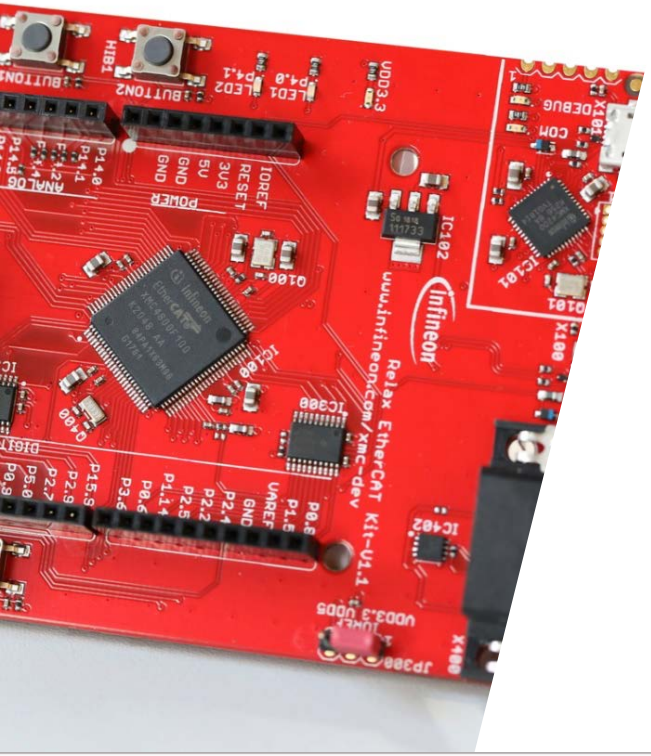


GUI

System-level demonstrator

- Dedicated to Condition monitoring & Predictive maintenance in HVAC
- Included features:
  - **Air flow measurement** at compressor with XENSIV™ DPS368 Barometric Pressure Sensor
  - Fan & compressor **current measurement** with XENSIV™ TLI4971 Current Sensor with XENSIV™
  - **Vibration & position monitoring of the compressor** TLI493D-A2B6 3D Magnetic Sensor
  - XMC4700 XMC™ 32-bit Arm® Cortex® microcontroller and **Wi-Fi connectivity**
  - **Secured connection** with OPTIGA™ Trust M
  - **Graphic user interface** illustrating changes in operating conditions – provided by Klika Tech
  - **Anomaly score and data intelligence** based on condition monitoring – provided by Klika Tech

Infineon, AWS and Klika Tech are developing a joint evaluation kit for enabling predictive maintenance in HVAC systems



- Kit includes different **set of sensors** incl. microcontroller and embedded security **for holistic condition monitoring** of HVAC systems

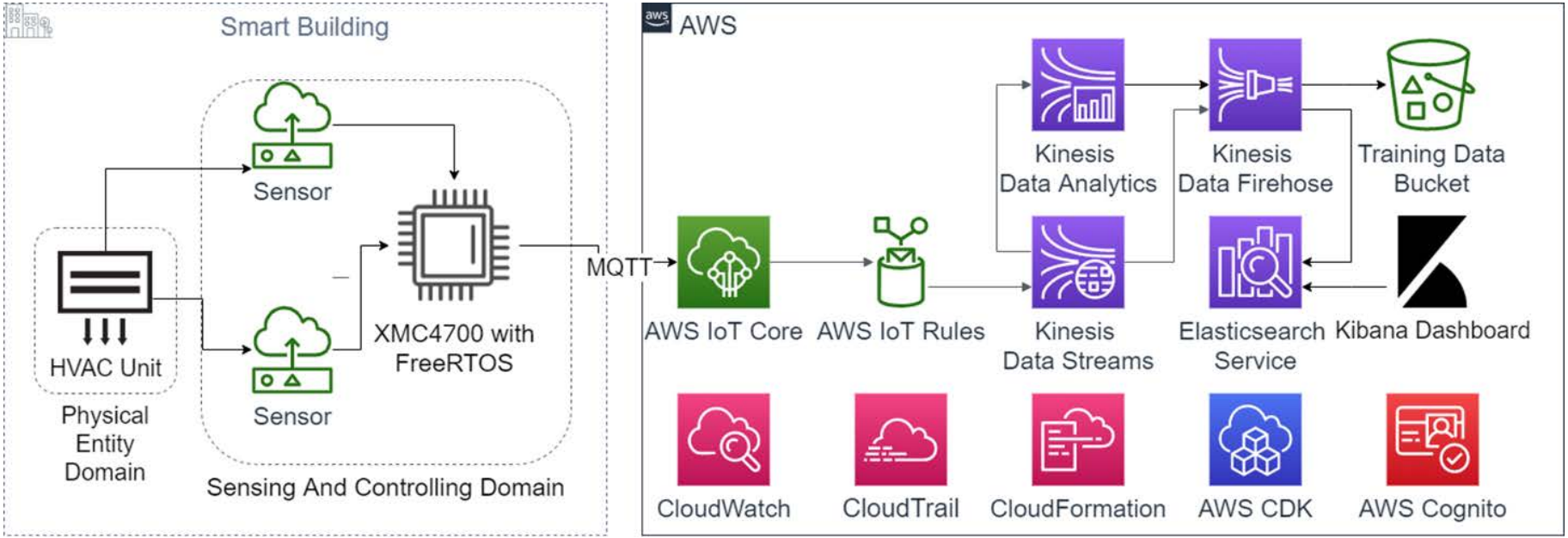
IFX hardware content:

- Pressure sensors
- MEMS microphones
- 3D magnetic sensors
- Hall sensors
- Current sensors
- Microcontroller
- Embedded security solution

- **All required software** for a basic setup of collecting data at the edge, preprocessing it and sending it to the AWS cloud is part of the kit
- AWS CloudFormation template and Quick Start guides **simplify setup** for testing
- Kit **ideal starting point** for customization and next steps towards a final solution for production

Preliminary information – may be subject to change

Example architecture provides intelligence from the edge to the cloud for HVAC units



A flexible platform for edge data collection with secure cloud delivery and analysis for real-time insights and ML-based automation

Hardware and software components provide an easily extendable platform

Hardware

- XENSIV™ sensor of portfolio with highly accurate sensors
- XMC™ family of industrial microcontrollers with comprehensive set of features
- OPTIGA™ Trust M for multi-account registration

Software

- Deploy, program, secure, connect and manage small, low-power devices
- MIT open source license
- Tiny, power-saving kernel
- Support for 40+ architectures
- Modular libraries
- Native integration with AWS

Hardware and software provides a platform for easily extending real-time, edge-to-cloud data management

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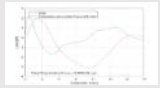
Infineon offers a broad semiconductor portfolio for condition monitoring and predictive maintenance for HVAC

Microphone

No distortions

Receive clear audio signals

Pressure



Best-in-class resolution

Measure height

Environmental

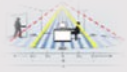
6x6mm²

World smallest form factor

Measure CO_2

3D Radar

Highest energy efficiency



Biometrics

3D ToF

Best-in-class resolution

3D mapping

Smart Ears, Smart Feeling, Smart Nose

Smart Eyes & Sixth Sense

Magnetic & Current Sensors

High variety of types and applications

BLDC, switches, metering, etc.

Motor Control

Intelligent motor ICs

Motor drives and IPMs, etc.

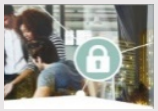
Microcontroller

Functional safety

Industry 4.0, autonomous cars, etc.

Embedded Security

Hardware security & authentication



TPM, mobile phone, edge devices, etc.

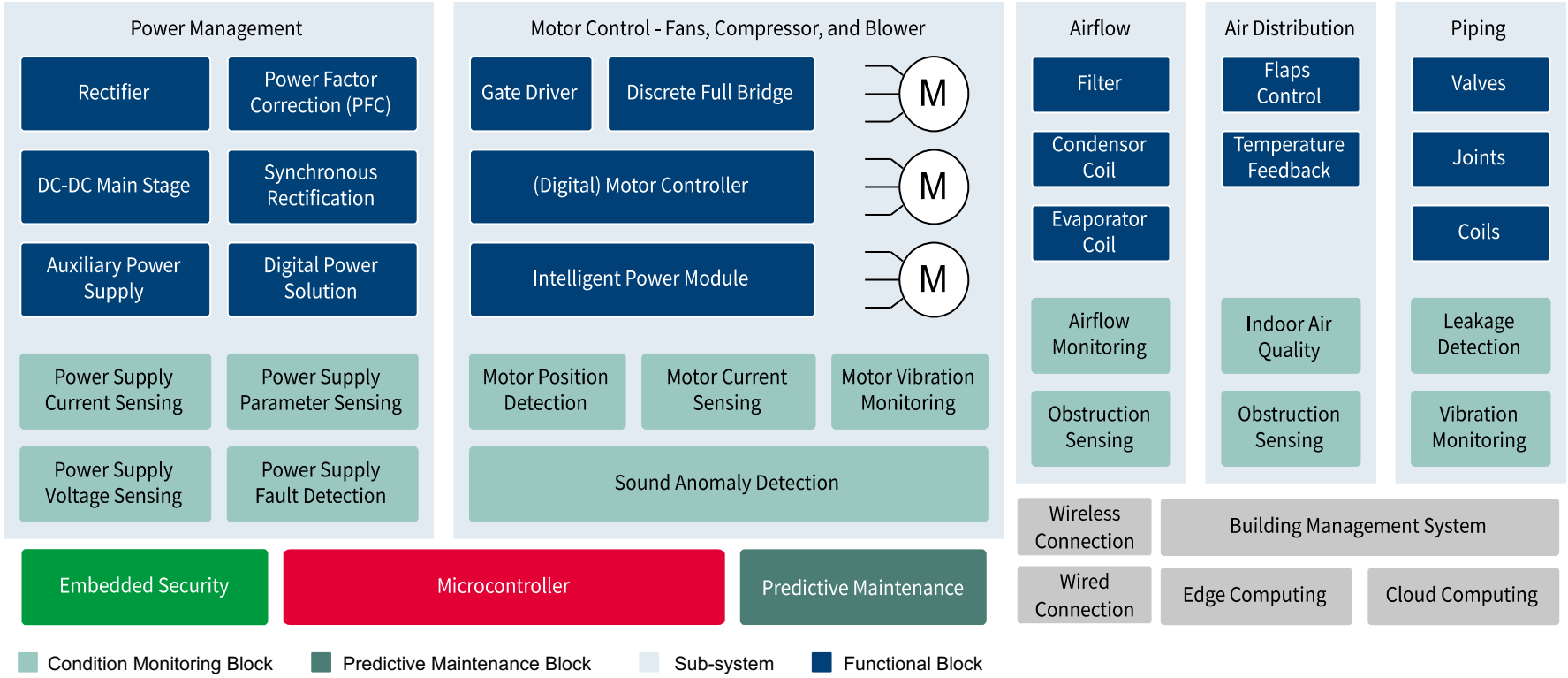
Power IC Solutions

Best-in-class solutions

Power supplies & control, LED driver, etc.

HVAC units consist of critical components whose failure has direct impact on system functionality

Block diagram



Infineon offers a broad set of products to enable predictive maintenance in HVAC systems

Air flow measurement: XENSIV™ DPS368

- **Miniaturized absolute digital barometric air pressure** sensor with temperature sensor
- **Ultra-high precision** (±2 cm) and low current consumption
- **Environmentally resistant** package

Noise monitoring: XENSIV™ IM69D130

- **High performance** digital MEMS microphone
- **Noise** free audio raw data: 69 dB[A] signal to noise ratio
- **Distortion free** audio signal: <1% total harmonic distortions up to 128 dBSPL

CO_2 measurement: XENSIV™ PAS CO_2 sensor

- Real CO_2 sensor ensuring **high quality data**
- **Small form factor** in SMD package for easier assembly
- Plug & play for **fast customer design to market**

Current measurements: XENSIV™ TLI4971

- **High precision** miniature coreless magnetic current sensor for AC and DC measurements
- **Accurate and highly linear** current measurement
- **Superior stability** over temperature and lifetime

Linear vibration measurement: XENSIV™TLE4997E

- **Highly accurate** programmable linear hall sensor
- **High linear** and ratiometric push-pull rail-to-rail output signal
- Digital temperature compensation

Vibration & Position monitoring XENSIV™ TLI493D-A2B6

- **Highly accurate** 3D magnetic Hall sensor for industrial applications
- Magnetic field range: +/- 160 mT
- **Broad microcontroller compatibility**

Infineon offers a broad set of products to enable predictive maintenance in HVAC systems

Opened & closed lid detection: XENSIV™ TLE4964-3M

- **Highly accurate** integrated Hall effect switch
- **Superior** supply voltage capability
- **Wide operating temperature range** and temperature stability of the magnetic thresholds

Speed and direction measurement: XENSIV™ TLI4966G

- **Double Hall switch** with two output pins with **direction & speed** information
- Operation from **unregulated power supply**
- Superior **temperature stability**

Data processing: XMC™ XMC4700

- 32-bit Arm® Cortex® M4 microcontroller
- **Higher performance CPU core** featuring DSP and FPU capabilities
- Broad and specialized set of **hardware peripherals** ideally suited for **motor control and SMPS applications**

Secured connection & authentication: OPTIGA™ Trust M

- **High-end** security controller
- Pre-provisioned / customer defined certificates
- Update certificates or data securely **via OTA**
- **Improved crypto performance** if compared to software only
- Simplify and **reduce costs** for production and deployment

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Summary

HVAC devices are crucial for buildings and their operations – malfunctioning can cause severe problems and costs

Condition monitoring and predictive maintenance ensure HVAC devices to work properly and help to provide next level of maintenance for the smarter buildings of tomorrow

Sensors and semiconductor solutions enable condition monitoring and predictive maintenance together with edge-computing and cloud infrastructure as part of an HVAC end-to-end solution

Together with partners AWS and Klika Tech, Infineon develops an evaluation kit for condition monitoring and predictive maintenance in HVAC equipment

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Part of your life. Part of tomorrow.